Physics 1st Secondary Physics

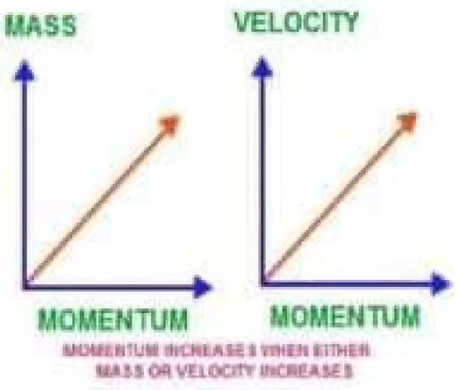
Final night

1) General Overview

Momentum:

These two physical quantities are related to a physical quantity known as:

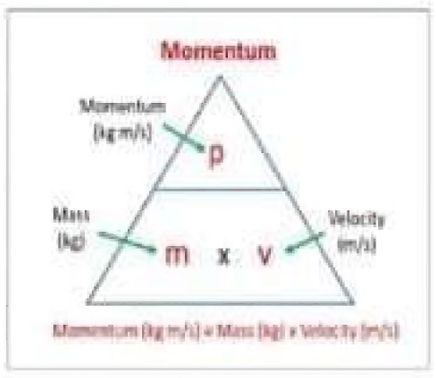
Momentum: (p=mv)



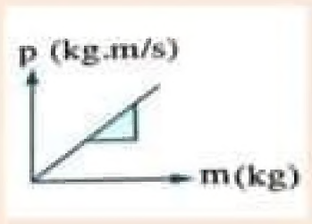
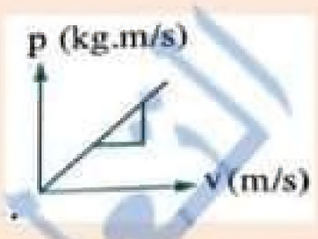
- Note that:

Momentum:

a. Vector quantity
b. At rest of any body is = zero
c. Its dimensional is MLT^{-1}
d. Its measuring unit is Kg.m/sec.



- Two factors affecting on it:

Mass	Velocity
The momentum is directly proportional to the mass of the object at constant velocity	The momentum is directly proportional to the velocity of the object at constant mass.
P=mv	p=mv
Slope=$\frac{p}{m}$ =v	Slope =$\frac{p}{v}$ =m
	

Newton 2nd law:

As this external force affect change the momentum of the object so , you can say that the external force is equal to the change in linear momentum in a certain period of time so:

$$F = \frac{\Delta P_l}{\Delta t}$$

And as: $\Delta P_l = \Delta(mv)$

And as m doesn't change during motion so,

$$F = m\frac{\Delta v}{\Delta t} \quad \text{.....} \bullet$$

But, $\frac{\Delta v}{\Delta t} = a$

As a is the acceleration

$f = m \cdot a$

So, by substitution by this equation in equation •,

F = m a

And its measuring unit is Newton or ($Kg\ m/s^2$)

Mass & Weight

COMPARISON FACES	MASS	WEIGHT
Definition	It's the resistance of the body to the change in its velocity	It's the force of earth gravity acting on the body .
Type of physical quantity	Scalar	Vector
Measuring unit	Kilogram ((Kg))	Newton ((N))
Constancy	Constant any where	Variable from one place to another.
Law	$M = \frac{F}{a}$	$F_g = mg$
Effect of changing position	Constant every where	Changes from position to another

Centripetal acceleration

$$\therefore a = \frac{v2}{r}$$

Centripetal Force

$$\therefore f=ma = \frac{mv2}{r}$$

$$F_{centripetal} = m\frac{v^2}{r}$$

$\frac{v^2}{r}$ is the centripetal acceleration

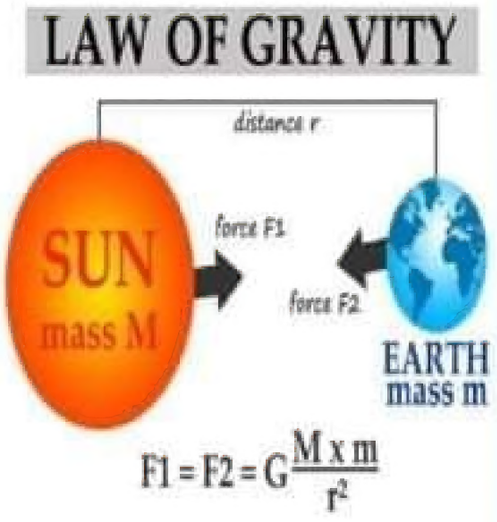
Tangential Velocity

$$\text{The tangential linear velocity} = \frac{distance\ (circule\ circumference)}{periodic\ time}$$

$$V=\frac{2\pi r}{T}$$

Newton's universal Gravitation Law

A body in the universe attracts another body by a force which is directly proportional to the product of their masses and inversely proportional to square the distance between their centers.



Gravitational Field

Gravitational field intensity (g):

It is the gravitational force acting on a mass of 1kg

✓ The gravitational field intensity of the earth at a point is equal to the acceleration due to gravity at this point

✓ By applying the universal gravitational law:

$F=mg$

$F=G\frac{Mm}{r^2}$

$\therefore mg=G\frac{Mm}{r^2}$

If the body is at height (h) above the Earth's surface:	$g=\frac{GM}{(R+h)^2}$
If the body is at depth (h) below the Earth's surface:	$g=\frac{GM}{(R-h)^2}$

∴ the gravitational field intensity is determined by the relation:

$$g=\frac{GM}{r^2}$$

Where: r= distance from center of earth or planet = R + h ,

R= radius of the Earth , h= height of the object from the surface of the Earth

✓ Unit of gravitational field intensity m/s^2 Or N/kg .

To compare the acceleration due to gravity for two planets:

$$\frac{g_1}{g_2}=\frac{M_1 R^2_2}{M_2 R^2_1}$$

orbital velocity of the a satellite (V)

Assume that a satellite of mass (m) moves with a velocity (v) in an orbit of radius (r) around the Earth of mass (M)

So the attraction force between the Earth and the satellite is the same centripetal force that acts on the satellite

$\therefore G\frac{Mm}{r^2}=\frac{mV^2}{r}$,

$V^2=\frac{GM}{r}$

$\therefore V=\sqrt{\frac{GM}{r}}$

Where (G) is the gravitational constant and radius of the orbit is r = R + h

if the height that the satellite was launched to is (h) & radius of Earth is R

$$\therefore V=\sqrt{\frac{GM}{R+h}}$$

2) Practicing Multiple Choices questions

1. According to Newton's first law, the object moves at.....acceleration unless acted by an external force.

a. uniform b. zero c. non uniform

2. The stationary object remains motionless if it is affected by a number of.....forces.

a. strong and horizontal b. balanced c. unbalanced d. weak and vertic

3. In the absence of resultant force acting on a static object, the object.....

a. moves at a uniform velocity b. moves at a uniform acceleration

c. remains motionless d. moves at a non uniform velocity

4. If the resultant force acting on a moving object in a straight line at uniform velocity is zero, the object.....

a. stops motion b. moves at a uniform acceleration

c. keeps motion at a uniform velocity d. moves at a non uniform velocity

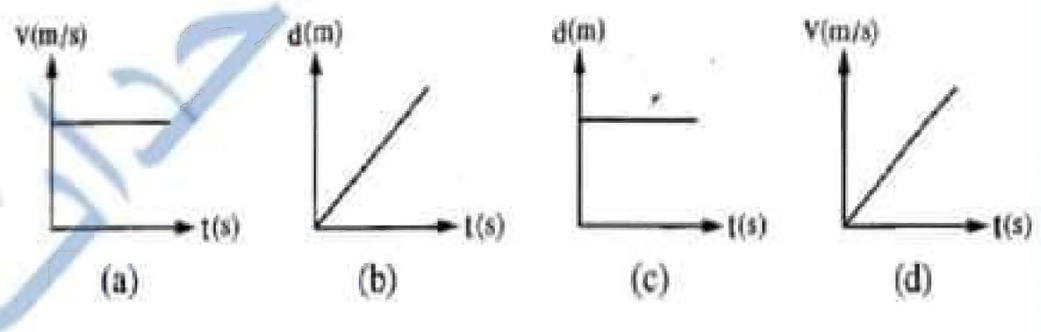
5. The mathematical formula that expresses Newton's first law is.....

a. ($\Sigma F \neq 0$) b. ($F = ma$) c. ($F_1 = -F_2$) d. ($\Sigma F = 0$)

6. A bicycle moves at uniform velocity in a straight line to East when the resultant force on the bicycle is.....

a. zero b. negative c. positive d. towards East

7. All the following graphs represent Newton's first law, except.....



(a) (b) (c) (d)

8. Force is measured by the.....

a. two pan balance b. ammeter c. spring balance d. ruler

9. When the direction of acceleration is opposite to the direction of velocity, the

a. resultant force decreases b. object velocity increases

c. object velocity is unchanged d. object velocity decreases

10. When the resultant force acting on a moving car is zero, the car.....

a. moves at positive acceleration b. moves at negative acceleration

c. moves at uniform velocity d. stops motion

11. Newton's first law is known as law of.....

a. reaction b. mass conservation

c. inertia d. energy conservation

12. An object moves at uniform acceleration when.....

a. it covers equal displacements in equal times

b. its velocity decreases with equal amounts in equal times

c. its velocity decreases with equal amounts in unequal times

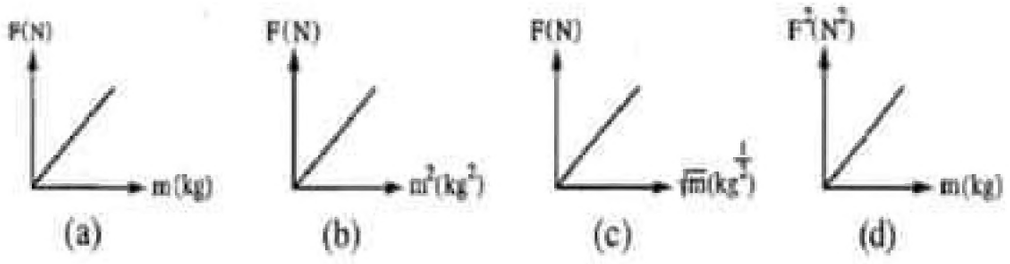
d. the resultant force acting on the object is zero

13. The resultant force acting on an object = its.....

a. mass x velocity b. mass x root of velocity

c. mass x rate of change of velocity d. half of mass x square of velocity

14. The diagram that represents Newton's second law is.....



(a) (b) (c) (d)

15. The unit of measuring force is the Newton that is equivalent to.....
a. kg.m/s b. m/s^2 c.J d. $kg.m/s^2$

16. The dimensions formula of force are.....
a. $^{ML.LT^{-2}}$ b. MLT^{-1} c. MLT^{-2} d. $M^2L^{-2}T^{-2}$

17. If a force of 2 N acts on an object of mass 1 kg, the object acquires
a. velocity 2 m/s b. acceleration 2 m/s^2
c. acceleration 1 m/s^2 d. velocity 1 m/s

18. An object of mass 6 kg at rest on a smooth surface is affected by a force of 18 N to move it at acceleration.....m/s
a.- 1/2 b. 1.5 c.3 d.6

19. The force that acts on an object of mass 5 kg to change its velocity from 7 m/s to 3m/s in an interval of 2s is.....
a. 10N b.5N c.2N d.10N

20. A force of 24 N acts on a body of mass 5 kg that moves on a horizontal surface at acceleration of 3 m/s . Frictional forces equal.....
a.6N b.8N c.9N d.39N

21. A wooden block of mass 2 kg is moving along a horizontal plane when affected by a force of 6 N. if the frictional force is 2 N, the acceleration of motion equals.....
a. 6 m/s^2 b.2m/s^2 c.-3m/s^2 d.-4m/s^2

22. If the mass of a body is decreased to half and the acting force is reduced to quarter,the acceleration of its motion.....
a. remains constant b. increases to its double
c. decreases to its half d. increases four times

23. If the force acting on a body is doubled and its mass of is decreased to half, the acceleration of its motion becomes.....
a. remains constant b.increases to its doule
c. decreases to its half d. decreases to its quarter

24. A vehicle of mass 500 kg and another of mass 1500 kg are moving at the same acceleration. The force acting on the heavier vehicle will be.....that of the less mass vehicle.
a. equal to b. a half of c. twice d. three times

25. Newton's third law is known as law of.....
a. inertia b. reaction c. universal gravitation d. Coulomb's

26. The mathematical formula that expresses Newton's third law is.....
a. $F = 0$ b. $F \neq 0$ c. $F = ma$ d. $F_1 = -F_2$

27. If a force of 9 N acts on an object, the reaction from the object equals.....
a. IN b.-9N c.0N d.9N

28. The idea of launching a rocket is based on the law of.....
a. inertia b. reaction c. universal gravitation d. Coulomb's

29. When the action is doubled, the reaction will
a. be halved b. increase four times
c. be doubled d. be unchanged

30. A characteristic of action and reaction is that they are.....
a. of the same type b. in the same direction
c. perpendicular to each other d. acting on the same body

31. When a force acts on a moving body in the same direction of motion, its velocity .....
a. decreases without changing direction b. Increases without changing direction
c. decreases and changes direction. d. increases and changes direction.

32. When a force acts on a moving body in an opposite direction to its motion, its velocity.....
a.decreases without changing direction b. Increases without changing direction
c. Changes direction only d.Changes and its direction also changes

33. When a force acts on a body in a direction normal to its direction of motion, its velocity .....
a. decreases without changing direction.
b. does not change but changes its direction.
c. changes and its direction also changes.
d. does not change without changing direction.

34. If a body moves in a circular path, its velocity changes in .....
a. magnitude only b. direction only
c. both magnitude and direction d. there is no correct answer

35. ..... is consider as centripetal force when it is normal to the direction of motion.
a. Tension force b. Attraction force
c. Friction force d. All of them

36. The centripetal force on a car moving in a curve is resulted due to .....
a. the gravitational force of Earth.
b. the friction force between the car tyres and the road.
c. the inertia affecting the car driver.
d. the force of brakes.

37. The centripetal acceleration is determined using the relation.....
a. $\frac{v}{r^2}$ b. v^2r c. $\frac{v^2}{r}$ d. $\frac{v^2}{r^2}$

38. The centripetal force is directly proportional to.....
a. r b. $\frac{1}{m}$ c. v^2 d. $\frac{1}{v^2}$

39. The centripetal force is directly proportional to.....
a. $\frac{1}{r^2}$ b. r c. $\frac{1}{m}$ d. m

40. The centripetal force is inversely proportional to.....
a. $\frac{1}{r}$ b. $\frac{1}{r^2}$ c. r d. r^2

41. If the tangential linear velocity is doubled and the radius of curvature is also doubled. So, the centripetal acceleration.....
a. decrease to its half b. is doubled
c. increases 4 times d. does not change

42. Two satellites (A) and (B) rotate around the Earth, having the same periodic time. If the orbit radius of satellite (A) equals four times the orbit radius of satellite (B), the ratio between the velocity of satellite (A) to that of satellite (B) equals .....
a. (2 : 1) b. (4 : 1) c. (1 : 2) d. (1 : 4)

43. Two objects A and B move on the circumference of a circle with the same velocity where $M_A = 2M_B$ So , the acceleration with which (A) moves is ..... that with which (B) moves
a. equal to b. double of c. half of d. quarter of

44. If the radius of a circular orbit is increased to four times its original value, the centripetal force required to make the speed of the body constant would be .....
a. decreased to half b. be unchanged
c. increased to double d. decreased to quarter its value

45. A car moves around a curve of radius 100 m with constant speed 20 m.s So, the centripetal acceleration equals ..... m.s
a. 4 b. 2 c. 5 d. 2.5

46. The quantity $\sqrt{\frac{Fr}{m}}$ indicates .....
a. speed of a body in a circular path. b. linear acceleration.
c. rate of change of speed d. centripetal acceleration.

47. The centripetal force equals.....
a. Mass x centripetal acceleration. b. Mass x Radius of curvature.
c. Mass x velocity d. Mass x Acceleration

48. A stone of mass 4 Kg is tied to a string of length 10 m rotates in a horizontal circle , if the tension force in the string is 160 N . S, the stone speed is ..... m/s.
a. 400 b. 100 c. 20 d. 10

49. An object of mass 6 Kg moves in a circle of circumference 6 π with constant speed 50 m/s, the centripetal force acting on the body is ..... N.
a. 400 b. 200 c. 180 d. 50

51. A person of mass 50 Kg on a bicycle moves on a curved road of radius 30 m with speed 2 m/s. If the centripetal force acting on him is 10 N so the mass of the bicycle is ..... Kg.
a. 25 b. 50 c. 75 d. 100

52. The ratio of the centripetal forces acting on two bodies of equal masses when the first moves with speed 5 m/s on a circle of diameter 4 m and the second moves with speed 10 m/s on a circle of diameter 8 m is .....
a. $\frac{2}{3}$ b. $\frac{1}{4}$ c. $\frac{1}{3}$ d. $\frac{1}{2}$

53. The tangential linear velocity of a body moving in circular path is determined from the relation .....
a. $\frac{2\pi r}{T}$ b. ar c. Fr d. mr

54. When a body moves on the circumference of circle of radius (r) with speed. (v). So, ...
a. The motion is accompanied by a centripetal force acting on changing the velocity direction.
b. The motion is with constant speed.
c. $v=\sqrt{centripetal\ acceleratoin\ x\ r}$
d. all of the previous.

55. If the tangential velocity with which a body moves in a circular path is 7 m/s and it makes 4 revolutions in two minutes. So, the radius of curvature of the path equals ..... m.
a. 30.6 b. 33.4 c. 25 d. 66.8

56. From the factors on which the centripetal force depends is / are .....
a. body temperature. b. Kind of material.
c. radius of rotation. d. all of the previous.

57. From life applications of centripetal force is / are .....
a. drying clothes. b. candy floss.
c. rotating barrel in the amusement park d. all of the previous.

58. force of attraction between two bodies in the universe is directly proportional to the.....
(a) square of their velocities. (b) product of their masses.
(c) square of the distance between them (d) distance between their centers

59. The acceleration due to Earth's gravity is .....
(a) a general universal constant.
(b) changeable according to the height from the Earth's surface.
(c) different through the seasons of the year.
(d) changeable depending on the distance between Earth and Sun

60.the centripetal force acting on a satellite of mass (m) rotates around Earth with velocity (v) in constant orbit of a distance ® from Earth's center equals.....
(a) $m\frac{v}{r^2}$ (b) $m\frac{v^2}{r}$ (c) $G\frac{m}{r}$ (d) $G\frac{m}{r^2}$

61. The universal gravitational constant is determined using the relation G = ...
(a) $\frac{Mm}{Fr^2}$ (b) $F\frac{Mm}{r^2}$ (c) $\frac{Mm}{r^2}$ (d) $\frac{Fr^2}{Mm}$

62. The ratio between the universal gravitational constant on the Earth's surface to that on the Moon's surface is ..... to unity.
(a) less than (b) more than (c) equal (d) Three quarter

63. The unit for measuring the universal gravitational constant is.....
(a) $N.m^2$ (b) N/m^2 (c) $N.m^2/Kg^2$ (d) $N.m^2$ Kg

64. The attraction force between Earth and Moon can be detected because of .....
(a) Their smaal masses. (b) Their large masses.
(c) Their smaal distances between them. (d) Their big radii.

65. If the distance between the centers of two masses decreased to its half , the force of attraction between them.....
(a) is doubled. (b) increases 4 times.
(b) decreases to its half. (c) does not change.

66. If the distance between the centers of two bodies is doubled,their masses are kept unchanged,the attractive force between them would be.....
(a) doubled. (b) halved. (c) quartered. (d) increases 4 times.

67. Two bodies of mass (m_1) and (m_2) and the distance between them is (r). If the mass of the first body is doubled and the distance between them is also doubled, the force of attraction between them.....
(a) does not change. (b) is doubled.
(c) decreases to its half. (d) becomes 4 times its value.

68. Two balls of masses 8 Kg and 20 Kg , the distance between their centers is 0.2 m, if the universal gravitational constant is G, so the attraction force between them =..... N
(a) 8000 G (b) 4000 G (c) 40 G (d) 8 G

69. If the distance between the centers of two identical balls is 1 m and the force of attraction between them is 1 N, the mass of each one of them equals.....
($G = 6.67 \times 10^{-11}\ N.m^2/Kg^2$)
(a) 1 Kg (b) 1.22×10^5 Kg (c) 2×10^5 Kg (d) 0.1 Kg

70. The intensity of Earth's gravitationl field can be determined using the relation g = ...
(a) $\frac{GM}{r^2}$ (b) $\frac{F}{r}$ (c) $\frac{\Delta v}{r}$ (d) $\frac{FM}{r}$

71. A planet of mass 5.98×10^{24} Kg and its radius R = 6378 Km, if $G = 6.67 \times 10^{-11}$ $N.m^2/Kg^2$, so the intensity of planet's gravitational field at a point lies at a distance 36000 Km from its surface equals ..... N/Kg
(a) 22.2×10^4 (b) 22.2×10^2 (c) 22.2×10^{-2} (d) 22.2×10^{-4}

72. The orbital velocity that required to keep the satellite rotating around the Earth is given by.....
(a) $\frac{M}{r}$ (b) gr (c) $\sqrt{\frac{Gm}{r}}$ (d) $\sqrt{gr}$

73. The velocity of a satellite rotating around the Earth depends on the following except.....
(a) Mass of the Earth.
(b) Mass of satellite.
(c) Height of satellite from the surface of the Earth.
(d) Radius of the Earth.

74. The orbital velocity of a satellite is inversely proportional to.....
(a) The mass of satellite.
(b) Square root of its mass.
(c) Radius of rotation of the orbit.
(d) Square root of the orbital radius.

75. Two satellite A and B rotate around the Earth having the same periodic time . If the orbit radius of satellite A equals 4 times the orbit radius of satellite B . So , the ratio between velocity of satellite A to that of satellite B equals .....
(a) 2 : 1 (b) 4 : 1 (c) 1 : 2 (d) 1 : 4

76. The time taken by a satellite to make full revolution around the Earth is given by .....
(a) $\frac{2\pi r}{v}$ (b) $\frac{2\pi r^2}{v}$ (c) $\frac{\pi r}{v}$ (d) $\sqrt{\frac{2\pi r^2}{v}}$

77. The velocity required by a satellite to rotate around the Earth.....
(a) Depends on its mass only.
(b) Depends on mass of the Earth only.
(c) Depends on both mass of the Earth and the distance between them.
(d) is constant.

78. The velocity of rotation required by the Earth to orbit the Sun depends on .....
(a) The mass of the Earth only.
(b) The mass of the Sun only.
(c) Both the mass of the Earth and the Sun besides the distance between them.
(d) The mass of the Sun and the distance between them.

79. A satellite rotates at height 12000 Km from a planet of mass 9.96×10^{22} Kg If the radius of the planet is 1063 Km and $G = 6.67 \times 10^{-11}\ N.m^2/Kg^2$ So the orbital velocity of the satellite = ... m/s.
(a) 744 (b) 713.13 (c) 311 (d) 249.9

Multiple Choice Model Answer

1)zero 2).balanced. 3).remains motionless.
4).keeps moving at uniform velocity. 5)$\Sigma F = 0$ 6)zero
7)d
8)spring balance 9)object velocity decreases.
10) moves at uniform velocity.
11) inertia. 12)b 13. c. mass × rate of change of its velocity
14. a. 15. d. $Kg.m/s^2$
16. c. MLT^{-2} 17. b. acceleration 2 m/s^2
18. c. 3 19. d. -10 N
20. c. -9 N 21. b. 2 m/s^2
22. c. decreases to its half 23. c. increases four times.
24 . d. three times 25. b. reaction 26. d. $F_1 = -F_2$
27. b. -9 N 28. Reaction.
29. c. be doubled 30. a. of the same type
31 .b. increases without changing direction.
32.a. decreases without changing direction.
33 .b. does not change but changes its directions.
34 .b. direction only. 35 .d. All of them
36 .b. the friction force between the car tyres and the road.
37 .c. v^2/r 38 .c. v^2 39.d. m
40 .c. r 41 .b. id doubled.
42 .b. (4:1). 43 .a. equal to
44. d. decreased to quarter its value. 45 .a. 4
46 .a. speed of a body in a circular path.
47 .a. Mass x Centripetal acceleration
48 .c. 20 49 .b. 200 50 .a. 25
51 d. 1/ 2 52 .a. $2\pi r/T$
53 .d. all the previous. 54 .b. $\overrightarrow{xb}$
55 .b. 33.4 56 .c. radius of rotation.
57 .d. all the previous.
58. b. product of their masses.
59. b. changeable according to the height from the Earth's surface.
60. b. mv^2/r 61. d. $\frac{Fr^2}{Mm}$
62. c. equal 63. c. $N.m^2/kg^2$
64. b. their large masses.
65. b. increases 4 times. 66. c. quartered.
67. c. decreases to its half. 68. b. 4000 G
69. b. 1.22 x 10^5 kg 70. a. $\frac{GM}{r^2}$
71. c. 22.2 x 10^{-2} 72. c. $\sqrt{Gm/r}$
73. b. mass of satellite.
74. d. square root of the orbital radius.
75. a. 2 : 1 76. a. $2\pi r$ /v
77. c. depends on both mass of the Earth and the distance between them.
78. d. the mass of the Sun and the distance between them.
79. b. 713.13

3)Problems with Answers

A static object of mass 20 kg is affected by a force 30 N. Find :
The acceleration acquired by the object,
The time taken by the object to move a distance of 75 m.

Ans

(a) $a = \frac{F}{m} = \frac{30}{20} = 1.5\ m/s^2$
(b) $d = v_i t + 0.5\ at^2$
$75 = 0 + 0.5 \times 1.5\ t^2$
$t = 10\ s$

Find the force that affects on an object of mass 30 kg to :
Accelerate it at 3 m/s
Speed it up from rest to 8 m/s during 6 s
Make it move from rest through 50 m in 5 s.
Change its velocity from 20 m/s to 10 m/s through a distance of 25 m

Ans

(a) $f = ma = 30 \times 3 = 90\ N$
(b) $a = = \frac{v_f - v_i}{t} = \frac{8-0}{6} = \frac{4}{3}\ m/s^2$
$F = ma = 30 \times \frac{4}{3} = 40\ N$
(c) $d = v_i t + 0.5\ at^2$
$50 = 0 + 0.5 \times a \times (5)^2$
$a = 4\ m/s^2$
$F = ma = 30 \times 4 = 120\ N$
(d) $v_f^2 - v_i^2 = 2\ ad$
$(10)^2 - (20)^2 = 2 \times a \times (25)$
$100 - 400 = 2 \times a \times (25)$
$a = -6\ m/s^2$
$F = ma = 30 \times -6$
$F = -180\ N$

A person stood putting one foot on a balance and the other foot on another balance Each balance read 300 N, what is the mass of the person? When the person pressed more on one balance than the other, this balance read 400 N. What is the reading of the other balance? (Knowing that the free all acceleration = 10 m/s^2) (60 kg, 200 kg)

Ans

$W = 300 + 300 = 600\ N$
$M = \frac{w}{g} = \frac{600}{10} = 60\ Kg$
The balance reading = 600 – 400 = 200 N

A body has a mass of 50 kg on Earth where the acceleration due to gravity = 9.8 m/s^2.
Find :
a. The body weight on Earth .
b. The body mass on moon.

Ans

(490 N , 50 kg)

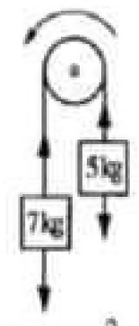
(a) $w = mg = 50 \times 9.8 = 490\ N$
(b) Mass of object (constant) = 50 Kg.

A force of 24 N acts on an object of mass 5 kg to move it in a horizontal plane at acceleration 3 m/s^2. Find the frictional force. (9 N)

Ans

15) Moving force = $ma = 5 \times 3 = 15\ N$
Friction force = $F_{moving} = F_{acting}$
$= 15 - 24 = -9\ N$
-ve sign indicates that the friction acts in the opposite direction of motion

Calculate the acceleration by which the two loads move; the mass of the first load = 5 kg and the other=7 kg, neglecting the frictional force.



(1.67 m/s^2)

Ans

*Mass 7 Kg
$F = w - F_T$
$Ma = mg - F_T$
$7a = (7 \times 10) - F_T$
$F_T = 70 - 7a$

*Mass 5 Kg:
$F = F_T - w$
$5a = F_T - 5 \times 10$
$F_T = 5a + 50$

$5a + 50 = 70 - 7a$
$12a = 20$
$A = \frac{20}{12} = 1.67\ m/s^2$

An elephant pulls a wooden lump of mass 0.5 ton along the ground at uniform velocity by a rope as shown in figure, Given that friction force between the lump and ground is 200 N, find:
a) The tension force in the rope.
b) The reared tension force in the rope to make the lump move at acceleration (200 N -1200N)

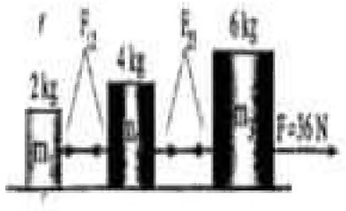
Ans

(a) Since the body moves with uniform velocity
$\therefore \sum F = zerp$
$F_{tension} + F_{friction} = 0$
$F_{tension} = -F_{friction}$
$= -(-200) = 200\ N$
(b) $\sum F = ma$
$F_{tension} + F_{friction} = ma$
$F_{tension} = (500 \times 2) - (-200)$
$= 1200\ N$

.Three masses are connected together by weightless threads as shown in figure They are pulled on a smooth surface by a horizontal force, Find :

a. The common acceleration of these masses

b. The tension force in each thread.



Ans

(a) $a = \frac{F}{m_1+m_2+m_3} = \frac{36}{12} = 3\ m/s^2$

(b) $F_{12} = (m_1 + m_2)a = 6 \times 3 = 18\ N$

If the mass of the planet Mercury is 3.3×10^{23} Kg and its radius is 2.439×10^{6} m, what is the weight of abody of mass 65 Kg on Mercury and what is the weight of the same object on the Earth (Knowing that $G = 6.67 \times 10^{-11}\ N.m^2/Kg^2$)?

(240.5 N, 637 N)

Ans

* The acceleration due to gravity on Mercury

$g = G\frac{M}{r^2} = 6.67 \times 10^{-11} \times \frac{3.3 \times 10^{23}}{(2.439 \times 10^6)^2} = 3.7\ m/s^2$

* The weight on Mercury

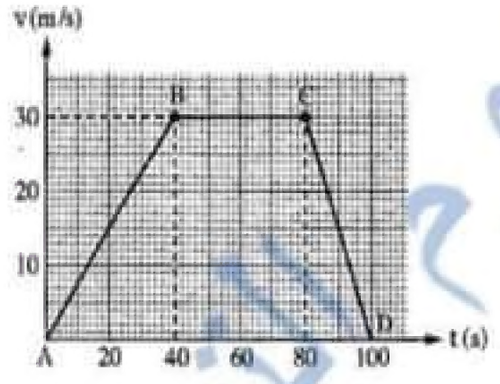
$W = mg = 65 \times 3.7 = 240.5\ N$

* The weight on Earth

$W = mg = 65 \times 9.8 = 637\ N$

. An object of mass 80 kg is moving during 100s according to the graphical relationship shown in the diagram :

Ans



(a) $V_{max} = 30$ m/s

(b) * Fro (A) to (B) moves with uniform positive acceleration

* From (B) to (C) moves at constant velocity.

(C) * From (A) to (B)

$a = \frac{\Delta v}{\Delta t} = \frac{30}{40} = \frac{3}{4}\ m/s^2$

$F = ma = 80 \times \frac{3}{4} = 60\ N$

* From (B) to (c)

a = zero , F = zero

* From (C) to (D) :

$A = -\frac{30}{20} = -\frac{3}{2}\ m/s^2$

$F = ma = 80 \times -\frac{3}{2} = -120\ N$

A bicycle rider moves in a circular path at a tangential velocity of 13.2 m/s. If the radius of the path is 40 m and the force keepi circular path equals 377 N, calcul[illegible] the mass of both the bicycle a

Ans

$F = \frac{mv^2}{r}$

$M = \frac{Fr}{v^2} = \frac{377 \times 40}{(13.2)^2} = 86.5\ kg$

A body of mass 100 g moves along the circumference of a circle of radius 50 cm at a uniform circular motion. If it takes a time of 90 s to make 45 complete revolutions, calculate:

(a) Periodic time.

(b) Linear velocity.

(c) Centripetal acceleration. (2 s, 1.57 m/s, 4.9 m/s^2)

Ans

(a) $T = \frac{90}{45} = 2$ s

(b) $v = \frac{2\pi r}{T} = \frac{2\pi \times 0.5}{2} = 1.57$ m/s

(c) $a = \frac{v^2}{r} = \frac{(1.57)^2}{0.5} = 4.9\ m/s^2$

If the centripetal acceleration for an object is 10 m/s^2, calculate the centripetal acceleration for the same object if its velocity is doubled and its radius of rotation decreased to its half value.

Ans (80 m/s^2)

$v_2 = 2\ v_1$, $r_2 = \frac{1}{2} r_1$

$a_2 = \frac{v_2^2}{r_2} = \frac{(2v_1)^2}{\frac{1}{2}r_1} = 8\frac{v_1^2}{r_1} = 8\ a_1$

$a_2 = 8\ a_1$, $a_2 = 8 \times 10 = 80\ m/s^2$

Calculate the attraction force between the sun and Jupiter planet, Knowing that:

Universal gravitational const. = $6.67 \times 10^{-11}\ N.m^2/Kg^2$

Mass of the sun = 1.989×10^{30} Kg

Mass of Jupiter = 1.898×10^{27} Kg

The mean orbital radius of Jupiter around the sun = 7.786×10^{11} m

(4.15×10^{23} N)

Ans

$F = G\frac{Mm}{r^2} = 6.67 \times 10^{-11} \times \frac{1.989 \times 10^{30} \times 1.898 \times 10^{27}}{(7.786 \times 10^{11})^2} = 4.15 \times 10^{23}\ N$

A planet of mass 5 times the mass of the Earth and its diameter 5 times that of the Earth. Calculate the ratio of the acceleration due to gravity on Earth's surface to that on the planet.

$(^5/_1)$

Ans

$$m_p = 5\ m_e \qquad , r_p = 5\ r_e$$

$$\frac{g_g}{g_p} = \frac{m_e\ r_p^{\ 2}}{m_p\ r_e^{\ 2}} = \frac{m_e\ x\ 25\ r_e^{\ 2}}{5\ m_e\ x\ r_e^{\ 2}} = \frac{5}{1}$$

) A satellite rotates in an orbit at height (h) 300 Km from the Earth's surface. Find:
(a) The orbital velocity.
(b) The periodic time of the satellite around the Earth.
(c) The centripetal acceleration of its motion.
(knowing that radius of the Earth 6378 Km, acceleration due to gravity at the Earth's surface = 9.8 m/s^2) (8.09×10^3 m/s, 5.18×10^3 s, 9.8 m/s^2)

Ans

(a) $g = G\frac{GM}{r^2}$ $\qquad M = \frac{gr^2}{G}$

$$v = \sqrt{G\frac{M}{r}} = \sqrt{\frac{G}{r}\ x\frac{gr^2}{G}} = \sqrt{gr}$$

$$v = \sqrt{(9.8)x\ (6378 + 300)x10^3}$$

$$= 8.09\ x\ 10^3\ m/s$$

(b) $T = \frac{2\pi r}{v} = \frac{2\pi\ x(6378+300)x\ 10^3}{8.09\ x\ 10^3}$

$$= 5.18\ x\ 10^3 s$$

(c) $a = \frac{v^2}{r} = \frac{(8.09\ x10^3\ )^2}{(6378+300)x\ 10^3} = 9.8\ m/s^2$

) Two balls having the same mass and the distance between their centers 2 m and the attraction force between them is 6.67×10^{-9} N. Calculate the mass of each ball.

Ans

$$F = G\frac{m_1 m_2}{r^2} = G\frac{m^2}{r^2}$$

$$m^2 = \frac{Fr^2}{G} = \frac{6.67\ x\ 10^{-9}\ x\ 4}{6.67\ x\ 10^{-11}} = 4\ x\ 10^2$$

$$m = \sqrt{4\ x10^2} = 20\ kg$$

4)Trial Test + Answers

First: Trial Test

Choose The correct Answer:

1.If the momentum of an object is doubled and its mass decreased to half, its velocity.....

a. doesn't change.

b. decreases to half.

C. increases four times.

d. increases to the double

2. The resultant force acting on an object = Its.....

a. mass × Velocity

b. mass × Root of velocity

c. mass × Rate of change of its velocity

d. half of mass × square of velocity

3. If a force of 2 N acts on an object of mass 1 kg , the object acquires.....

a. velocity 2m/s.

b. acceleration 2 m/s^2

c. acceleration 1 m/s^2.

d. velocity 1 m/s.

4. A force of 24 N acts on a body of mass 5 kg that moves on a horizontal surface at acceleration of 3 m/s2. Frictional forces equals .....

a. -6 N.

b. 8 N

c. -9 N

d. 9 N

5. If the mass of a body is decreased to half and the acting force is reduced to quarter, the acceleration of its motion.....

a. remains constant.

b. increases to its double.

c. decreases to its half.

d. increases four times.

6. A static body was displaced by 45 m in 3 sec. If the mass of the body is 50 kg . Find :

1) The final momentum

a. 200 kg.m/s

b. 500 kg.m/s

c.1500kg.m/s

d.1000kg.m/s

2) The acting force

a. 300 N

b. 500 N

c. 600 N

d. 700 N

7.When a force act on a moving body in an opposite direction to its motion, its velocity .....

a. Decreases without changing direction.
b. increases without changing direction
c. changes direction only
d. changes and its direction also change

8. When a force acts on a body in a direction normal to its direction of motion, its velocity.....

a. Decreases without changing direction.
b. Does not change but changes its direction.
c. Changes and its direction also change.
d. Does not change without changing direction

9.Two satellites orbit the earth at the same speed in identical orbits. Satellite A is twice the mass of satellite B. How does the centripetal acceleration of satellite A compare with that of satellite B ?.

a. four times as much.
b. twice as much
c. the same
d. one-half as much

10. Two identical cares are moving at the same constant speed taking different exit ramps from the highway. Ramp 1 is a circular of radius of 25 m. Ramp 2 is a circular of a radius of 50 m. what is the centripetal force on the car taking ramp 2 compared with that for the car taking ramp 1?

a. Ramp 2 requires four times the centripetal force.
b. Ramp 2 requires two times the centripetal force.
c. Ramp 2 requires the same the centripetal force.
d. Ramp 2 requires one-half the centripetal force.

11. Two satellite A and B rotate around the earth, having the same periodic time. If the orbit radius of satellite A equals four times the orbit radius of satellite B,the ratio between the velocity of satellite A to that of satellite B equals .....

a) (2:1)
b) (4:1)
c) (1:2)
d) (1:4)

12.Two objects A and B move on the circumference of a circle with the same velocity where $M_A = 2M_B$ so, the acceleration with which A moves is ..... that with which B moves.

a) equal to
b) double of
c) half of
d) quarter of

13. The quantity $\sqrt{fr/m}$ indicates .....

a) speed of a body in a circular path.
b) linear acceleration
c) rate of change of speed.
d) centripetal acceleration

14. A person of mass 50kg on a bicycle moves on a curved road of radius 30 m with speed 2 m/s . If the centripetal force acting on him is 10 N ,so the mass of the bicycle is .....kg

a) 25
b) 50
c) 75
d) 100

15. A 1000 kg experiences a centripetal force of 1.8×10^5 N while making a turn. The car is moving at a constant speed of 30 m/s . what is the radius of the turn?.....

a) 0.2 m
b) 1m
c) 2m
d) 5m

16. Two similar balls each of mass (m) and radius (r), placed in contact to each other, then the gravitational force between them is given by the relation....

a. $F=\frac{G\,m^2}{r^2}$
b. $F=\frac{G\,m^2}{4r^2}$
c. $F=\frac{2G\,m}{r^2}$
d. $F=\frac{G\,m^2}{2r^2}$

17. If the distance between the centers of two masses decreased to its half, the force attraction between them:

a. Is doubled
b. Increases 4 times
c. Decreased to its half
d. Doesn't change

18. If the distance between the centers of two bodies is doubled, their masses are kept unchanged, the attractive force between them would be.....

a. Doubled
b. Halved
c. Quartered
d. Increases 4 times

19. Two balls of masses 8kg and 20kg, the distance between their centers is 0.2m, if the universal gravitational constant is G, so the attraction force between them =.....N

a. 8000G
b. 4000G
c. 40G
d. 8G

20. If the radius of a planet is $7.14X10^{7}$m and its mass is $1.9X10^{27}$kg and G= $6.67X10^{-11}N.m^2/kg^2$,then the attraction force acting on an object of mass 1kg at the planet's surface and the acceleration due to the gravity on the planet's surface are equal .....

a. 24.86N , 24 m/s^2
b. 24N , 24m/s^2
c. 24.8N, 24m/s^2
d. 24.86N, 24.86m/s^2

21. The ratio between the acceleration due to the gravity on the Moon and on the Earth, knowing that: Mass of the Earth $5.679X10^{24}$ kg and its radius is $6.4X10^{6}$m &Mass of the Moon $7.35X10^{22}$kg and its radius $1.74X10^{6}$m Is equal ...

a. 0.1664
b. 0.155
c. 0.33
d. 0.225

22. A planet of 5 times the mass of the Earth and its diameter 5 times that of the Earth, calculate the ratio of the acceleration due to gravity on the Earth's surface to that on the planet.....

a. 1/5
b. 5/1
c. 2/1
d. 1/2

23. The orbital velocity that is required to keep the satellite rotating around the Earth is given by.....

a. $\frac{M}{r}$
b. gr
c. $\sqrt{GM/r}$
d. $\sqrt{gr}$

24 The velocity of the satellite rotating around the Earth depends on the following except.....

a. Mass of the Earth
b. Mass of the satellite
c. Height of the satellite from the surface of the Earth
d. Radius of the Earth

25 . A satellite rotates at height 1200km from a planet of mass $9.96X10^{22}$ kg if the radius of the planet is 103 km and G= $6.67X10^{-11}$ $N.m^2/kg^2$, so the orbital velocity of the satellite= .....m/s

a. 744
b. 713.13
c. 311
d. 249.9

26. A satellite rotates in an orbit at height(h) 300km from the Earth's surface find: (the orbital velocity- the periodic time of the satellite around the Earth – the centripetal of its motion) knowing that: radius of the Earth 6378km, acceleration due to gravity at the Earth's surface= $9.8m/s^2$)

a. $8.06X10^3m/s$, 5s, $9.8m/s^2$
b. $8.09X10^3m/s$, $5.18X10^3s$, $9.8m/s^2$
c. $8.09X10^3m/s$, $5.81X10^3s$, $9.8m/s^2$
d. No correct answer

27. When the momentum of an object is equalized with its velocity .....

a. When the mass of the object = zero
b. When the mass of the object =1kg
c. When the mass of the object is vanish
d. When the velocity = 9m/s

28. An object of mass 5kg moves in a circle of radius 2m at a uniform speed 5m/s. So, The linear acceleration

a. 12.5 m/sec2
b. 62.5 m/sec2
c. 12.5 m/sec
d. Zero

29. The ratio between the universal gravitational constant on the earth's surface to that on the moon's surface is..... To unity.

a. Less than
b. More than
c. Equal
d. Three quarter

30.

The approximate value of g at an altitude above Earth equal to one Earth diameter is:

A. $9.8 m/s^2$
B. $4.9 m/s^2$
C. $2.5 m/s^2$
D. $1.9 m/s^2$
E. $1.1 m/s^2$

Second: Model Answer of the Trial Test

1. c	16. b
2. c	17. b
3. b	18. c
4. c	19. b
5. c	20. d
6. 1) c 2)b	21. a
7. a	22. b
8. b	23. c
9. c	24. b
10. d	25. b
11. b	26. b
12. a	27. b
13. a	28. d
14. a	29. c
15. d	30. E

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Unit three
Chapter One : Laws of Circular Motion

When a force acts on a moving body

and

The direction of force is in the same direction of motion	The direction of force is opposite to direction of motion	The direction of force is normal to that of motion
The magnitude of velocity increases & its direction does not change	The magnitude of velocity decreases & its direction does not change	The direction of velocity changes & its magnitude does not change

EX: Breaking Force, Friction Force

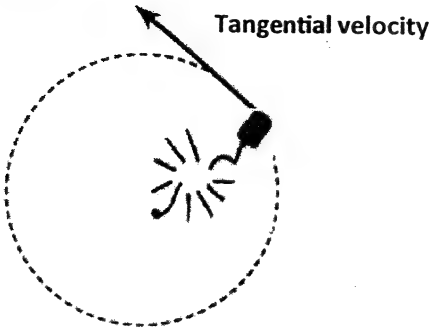
Motion in a circle

- Let a stone be attached to a string . Hold the other end by your hand , then whirl the stone around in a circle . Increase the velocity of the stone during rotation . What do you notice ? Let the stone go freely , in which direction will the stone go ?

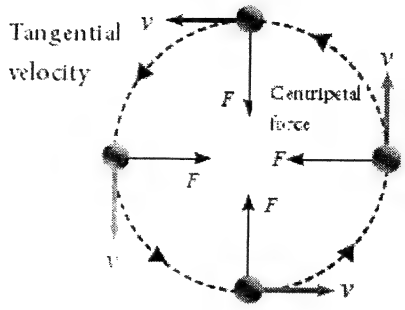
From the previous, we conclude that :

- For body to move in a circle , a force (F) normal to its direction of motion and directed towards the centre of the circle has to act on the body to force it to continue its circular motion .
- If this force is removed , the body will rush in the direction of the tangent to the circular path , (at the point where the force is removed) at a constant velocity in

magnitude and direction and moves in a straight line . This velocity is called tangential velocity (v) .



Direction of body motion when the string is cut



Direction of force & velocity in the circular motion

Uniform circular motion :

- It is the motion of a body in a circular path at a constant speed but changeable direction .
- The force acting on this body towards the center is called the centripetal force .

Centripetal force :

- It is the force acting continuously in a direction normal (⊥)to the motion of a body , Accordingly , its path changes from being straight into circular .

Types of Centripetal force :

1. Tension force (F_T) [stretched string] .
2. Gravitational force (F_G) [between moon , Earth , sun , satellite] .
3. Friction force (F_f) [between the road and car tyres in circular path or a curve]
4. Reaction force (F_N) : When the circular path is inclined at an angle to the horizontal so the centripetal force is the sum of the two components of reaction and friction .
5. Lifting force (F_L) : the horizontal component of the lifting force on the aeroplane acts as a centripetal force .

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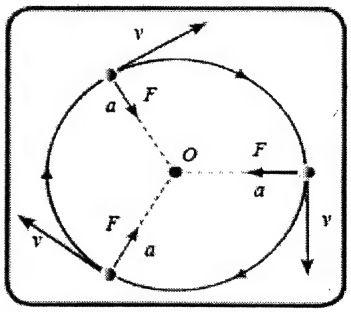
Centripetal Acceleration:

- When a force (F) acts normally to the direction of body motion that has mass (m) moving at velocity (v) in a circular path of radius (r) a change in the direction of its velocity happens .
- Accordingly The body will acquire an acceleration (a) called the centripetal acceleration .
- Its direction is the same as the direction of the centripetal force .
- Looking at figure, it is obvious that each of velocity (v), force (F) and acceleration (a) has its constant magnitude but is continuously changing its direction.



Centripetal acceleration (a):

It is the acceleration acquired by the body in a circular motion due to a change in the direction of its velocity .

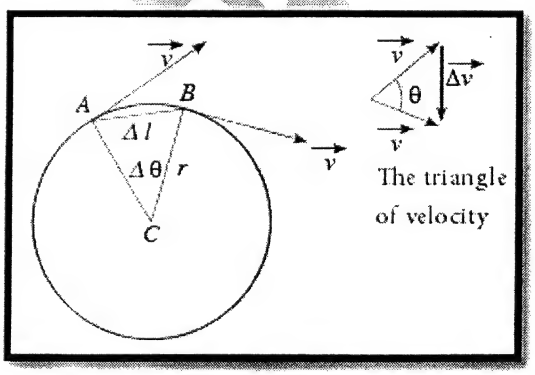
Calculating centripetal acceleration :

The two Δ Δ are similar

(CAB) (triangle of velocity)

$$\therefore \frac{\Delta L}{r} = \frac{\Delta V}{v}$$

$$\therefore \Delta V = V \frac{\Delta L}{r}$$



If the body takes time (Δt) to transfer from (A) to (B)

$$\therefore a = \frac{\Delta V}{\Delta t} = \frac{V \Delta L}{\Delta t\, r} = \frac{V \Delta L}{\Delta t\, r} \rightarrow (1)$$

$$\because \frac{\Delta l}{\Delta t} = v \quad \text{subs in (1)}$$

$\therefore a = \frac{VV}{r}$ $\therefore a = \frac{V^2}{r}$

$F_{centripetal}$ = Mass × centripetal acceleration ($F : Ma_C$)

$\therefore F_C = \frac{MV^2}{r}$

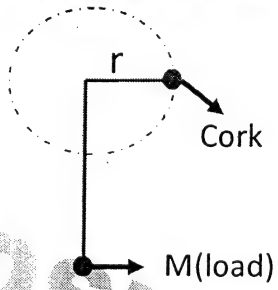
- **Linear velocity (tangential velocity)**

$V = \frac{distance}{time}$ **if the body makes one cycle**

$V = \frac{2\pi r}{T}$ **(T → Periodic time)**

Solved Example

- **In the experiment the mass of the cork stopper was (13g) and it was rotated in a horizontal circular path of radius (0.93m)** to make (50 revolutions) in time (59s). **Calculate the mass of load attached to the string .**



Calculating periodic time [Time of one cycle] :

$$T = \frac{\text{Total Time}}{\text{No of revolutions}} = \frac{59}{50} = 1.18 \text{ s}$$

Calculating Velocity :

$$V = \frac{2\pi r}{T} = \frac{2 \times 3.14 \times 0.93}{1.18} = 4.9 \text{ m/s}$$

Calculating tension force ($F_T = F_C$) :

$$F = m \frac{V^2}{r} = 13 \times 10^{-3} \times \frac{(4.9)^2}{0.93} = 0.34N$$

Calculating mass of the load :

$$M = \frac{F}{g} = \frac{0.34}{9.8} = 0.035kg$$

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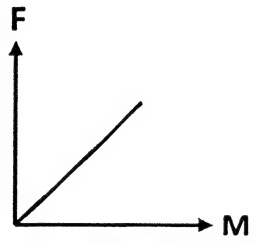
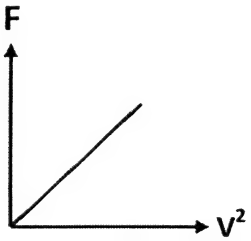
Factors affecting centripetal force [$F = \frac{m.v^2}{r}$]

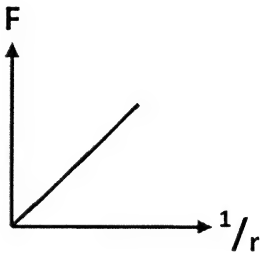
1. Mass of body [$F \alpha M$] at const [v , r]
2. Tangential velocity [$F \alpha v^2$] at const [m , r]
3. Radius of circular path [$F \alpha {}^1/_r$] at const [m , v^2]



Slope = ...



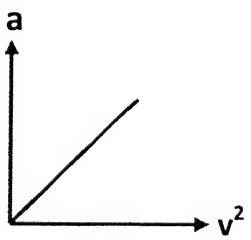
Slope = ...



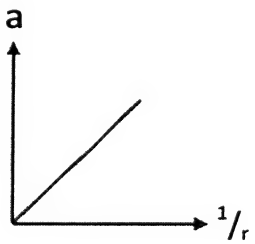
Slope = ...

Factors affecting centripetal acceleration [$a = \frac{v^2}{r}$]

1. Tangential (linear) velocity [$a \alpha v^2$] at const [r]
2. Radius of circular path [$a \alpha {}^1/_r$]



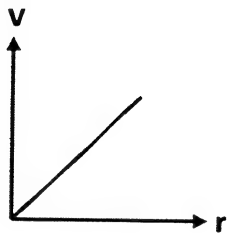
Slope = ...



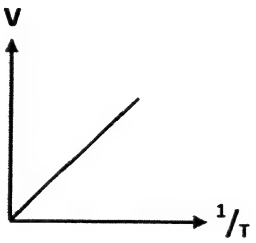
Slope = ...

Factors affecting tangential velocity [$v = \frac{2\pi r}{T}$]

1. Radius of circular path (r) [$v \alpha r$] at const [T]
2. Periodic Time (T) [$v \alpha {}^{1}/_{T}$] at const [r]



Slope = ...



Slope = ...

Solved Example

1) A stone of mass (600g) is attached to a string of length (10cm) , rotating at velocity (3m/s). Calculate the centripetal force . What do you expect if the maximum tension force the string can afford is (50N) .

Solution :

Calculating the centripetal force :

$$T = m\frac{v^2}{r} = 0.6 \times \frac{(3)^2}{0.1} = 54 \text{ N}$$

Since the required centriptal force in more than the maximum tension force that the string can afford , the string will be cut . The stone moves in a striaght line at the moment of cutting the string tangent to the circular path .

2) A car of mass 1000 kg rotates in a curve of radius 50 m with velocity 5m/s . find :
   a) Centeptal force acting on the car .
   b) Perodic time .

Solution :

3) A body of mass 0.5 kg moves along the circumference of a circle of radius 2m with velocity 10 m/s find :
   a) Linear acceleration .
   b) Centriptal accelation .
   c) Centriptal force .

Solution :

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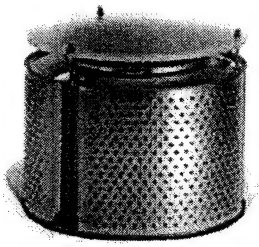
Give reason for :

1) The force required to move a bicycle in a curved path is less than that required to move a truck .
   - Because the centripetal force is directly proportional to mass and the truck has larger mass .
2) Trucks are not allowed to move along some dangerous curves
   - Because they have huge masses so they need huge centripetal force [$F_c \alpha M$]
3) Engineers define a certain velocity which should not be exceeded for the motion in curves road and high way .
   - ($F_C \alpha V^2$) So cars need large centripetal force to keep it in curve .
4) It is advisable to move with low speeds in dangerous curves .
   - Dangerous curves has small radius so F_C increases ($F_c \alpha {}^1/_r$) so the car needs more (F_C) to keep in a circle so V should be small to decrease F_c ($f_C \alpha v^2$)

- Skidding of objects away from the circlar path when the centriptal force is too weak to keep them in the path can be used in many life applicalions such as drying clothes , candy floss and the rotating barrel in the amusement park .For instance , water droplets adhered to clothes eithcertain forces . When the dryer tub rotates at high speeds , the adhesive force become insufficient to keep water droplets rotating . ASccordingly , they eject tangential to the circular path and separate from clothes .



When the drier rotates at a great velocity , water droplets are expelled tangential to the circumference of the tub .

Questions Chapter (1)

Write down the scientific term for each statement of the following:

1. The motion of an object along the circumference of a circle at a linear velocity of constant magnitude and changeable direction.
2. • A force always acts towards the center normally to the direction of the linear velocity during the motion of a body in a circular motion.
   • A force acting normal to the direction of motion of a body resulting in its motion in a circular path with constant speed.
   • The force acting continuously in a direction normal to the motion of a body and changes its path from being straight into circular.
   • The product of the body mass x centripetal acceleration with which it moves.
3. A force acts as a centripetal force normal to the direction of motion of a body pulling a string or a wire, in a circular path.
4. A force originates due to the attraction force between large bodies and acts as centripetal attracting force normal to the direction of motion of the body. So, it moves in a circular path.
5. A force originates due to the resistance of a surface to the motion of a body on it. This force acts as centripetal force when it is normal to the direction of motion of the body.
6. • The acceleration acquired by the body in a circular motion due to a change in its velocity.
   • The square of tangential velocity divided by radius of curvature.
   • A vector quantity defined as the change in the direction of constant velocity as time passes.
   • The acceleration with which a body moves in a circular path and directed towards the center.
   • An acceleration changes the direction of motion only.
7. The time taken by a body to make a complete revolution.

Choose the correct answer of the given answers:

1. When a force acts on a moving body in the same direction of motion, its velocity.....
   a. decreases without changing direction. b. increases without changing direction.
   c. decreases and changes direction. d. increases and changes direction.
2. When a force acts on a moving body in an opposite direction of its motion, its velocity.....
   a. decreases without changing direction. b. increases without changing direction.
   c. changes direction only. d. changes and its direction also changes.

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3. When a force acts on a body in a direction normal to its direction of motion, its velocity.....
   a. decreases without changing direction.
   b. does not change but changes its direction.
   c. changes and its direction also changes.
   d. does not change without changing direction.
4. If a body moves in a circular path, its velocity changes in.....
   a. magnitude only. b. direction only.
   c. both magnitude and direction. d. there is no correct answer.
5. .....is considered as centripetal force when it is normal to the direction of motion.
   a. Tension force b. Attractive force c. Friction force d. All of them
6. The centripetal force acting on a car moving in a curve is resulted due to.....
   a. the gravitational force of Earth.
   b. the friction force between the car tyres and the road.
   c. the inertia affecting the car driver.
   d. the force of brakes.
7. The centripetal acceleration is determined using the relation.....
   a. $\frac{v}{r^2}$ b. $v^2 r$. c. $\frac{v^2}{r}$ d. $\frac{v^2}{r^2}$
8. The centripetal force is directly proportional to.....
   a. r. b. $\frac{1}{m}$ c. v^2 d. $\frac{1}{v^2}$
9. The centripetal force is directly proportional to.....
   a. $\frac{1}{r^2}$ b. r. c. $\frac{1}{m}$ d. m.
10. The centripetal force is inversely proportional to a
    a. $\frac{1}{r}$ b. $\frac{1}{r^2}$ c. r. d. r^2
11. If the tangential linear velocity is doubled and the radius of curvature is also doubled. So, the centripetal acceleration.....
    a. decreases to its half. b. is doubled.
    c. increases 4 times. d. does not change.
12. Two objects A and B move on the circumference of a circle with the same velocity where $m_A = 2\ m_B$. So, the acceleration with which A moves is.....that with which B moves.
    a. equal to b. double of c. half of d. quarter of
13. If the radius of a circular orbit is increased to four times its original value, the centripetal force required to make the speed of the body constant would.....
    a. decreased to half. b. be unchanged.
    c. increased to double. d. decreased to quarter its value.

14. A car moves around a curve of radius 100 m with constant speed 20 $m.s^{-1}$. So, the centripetal acceleration equals.....$m.s^{-2}$.

a. 4 b.2 c.5 d.2.5

15. The quantity $\sqrt{Fr/m}$ indicates.....

a. speed of a body in a circular path. b. linear acceleration.

c. rate of change of speed. d. centripetal acceleration.

16. The centripetal force equals.....

a. mass x centripetal acceleration. b. mass x radius of curvature.

c. mass x velocity. d. mass x acceleration.

17. A stone of mass 4 kg is tied to a string of length 10 m rotates in a horizontal circle, if the tension force in the string is 160 N. So, the stone speed is.....m/s.

a. 400 b. 100 c.20 d. 10

18. An object of mass 6 kg moves in a circle of circumference 6 7t with constant speed 10 m/s, the centripetal force acting on the body is.....N.

a. 400 b.200 c. 180 d.50

19. A person of mass 50 kg on a bicycle moves on-a curved road of radius 30 m with speed 2 m/s. If the centripetal force acting on him is 10 N so the mass of the bicycle is.....kg.

a. 25 b.50 c. 75 d. 100

20. The ratio of the centripetal forces acting on two bodies of equal masses when the first moves with speed 5 m/s on a circle of diameter 4 m and the second moves with speed 10 m/s on a circle of diameter 8 m is .....

a. $\frac{2}{3}$ b. $\frac{1}{4}$ c. $\frac{1}{3}$ d. $\frac{1}{2}$

21 .The tangential linear velocity of a body moving in circular path is determined from the relation.....

a. $\frac{2\pi r}{T}$ b. ar. c.Fr. d.mr.

22. When a body moves on the circumference of circle of radius (r) with speed (v). So,.....

a. the motion is accompanied by a centripetal force acting on changing the velocity direction.

b. the motion is with constant speed.

c. $v = \sqrt{centrpetal\ acceleration \times r.}$

d. all of the previous.

23. A boy catches a string with a stone at its end and moves it in a horizontal plane as shown with the arrow(e) on the figure. If the boy leaves the string suddenly when the stone is at x. So the stone will move in.....direction.

a. $x\vec{c}$ b. $x\vec{b}$ c. $x\vec{a}$ d. $x\vec{d}$

24. If the tangential velocity with which a body moves in a circular path is 7 m/s and it makes 4 revolutions in two minutes. So, the radius of curvature of the path equals .....m.

a. 30.6 b.33.4 c. 25 d.66.8

25. From the factors on which the centripetal force depends is/are.....

a. body temperature. b. kind of material.

c. radius of rotation. d. all of the previous.

26. From life applications of centripetal force is / are.....

a. drying clothes. b. candy floss.

c. rotating barrel in the amusement park. d. all of the previous.

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Unit Three
Chapter two : Universal gravitation and circular motion

1- Gravitational Law of Newton :

- **A body in the universe attracts any other body by a force , this force is directly proportional to the product of their masses and inversely proportional to square of the distance between their centers .**

- $F \propto Mm$
- $F \propto \frac{Mm}{r^2}$
- $F \propto \frac{1}{r^2}$

$$F = G \frac{Mm}{r^2}$$

- $G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$ $(Kg^{-1}m^3s^{-2})$

  ↓

  Universal constant

- $G = \frac{Fr^2}{Mm}$ $\boxed{\frac{N.m^2}{kg^2}}$
- $\frac{N.m^2}{kg^2} = \frac{kg\ ms^{-2}\ .\ m^2}{kg^2} = kg^{-1}m^3s^{-2}$
- **D.F : $M^{-1}L^3T^{-2}$**

Universal constant [G]

- **It is the gravitational force (mutual force)between two bodies each of mass[1 kg] and the distance between their centers equals [1 m]**

2- Gravitational field:

- It is the space in which the gravitational forces appear

Intensity of Earth's gravitational field (g) :

- It is the attraction force of earth to a mass of (1 kg) . [Numerically equal free fall acceleration]

- $\because F = mg$
- $\therefore mg = G \frac{Mm}{r^2}$
- $\therefore g = \frac{GM}{r^2}$

- $\because F = G \frac{Mm}{r^2}$
- $r = R + h$

m m m

M	mass of Earth	(kg)
R	radius of Earth	(m)
h	height above earth's surface	(m)

- **If the body at height (h) or depth (h)**

- $g = \frac{GM}{(R+h)^2}$, $g = \frac{GM}{(R-h)^2}$

- **To compare (g)onto two diff. planets**

$$\frac{g_1}{g_2} = \frac{M_1 R_2^2}{M_2 R_1^2}$$

R_1 : radius of first planet .

R_2 : radius of second planet .

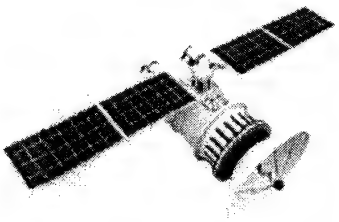
3- Satellite

- **Satellite : is a body falls freely towards the earth but it never reach its surface .**

- When the curvature of satellite path is parallel to the curvature of the earth's surface . it will rotate in this path and becomes an earth's follower as moon so it is called satellite .

• What happens :

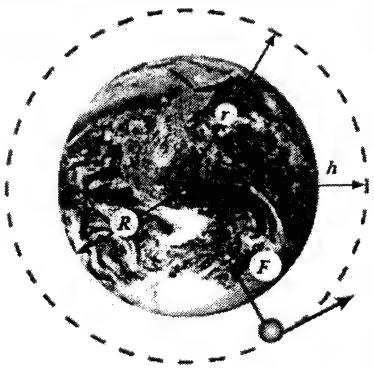
1- The satellite stops and its velocity become zero .
→ It would fall in a straight line towards the earth and fall onto it .



2- The gravitation force between the earth and the satellite vanishes .
→ The satellite moves in a straight line along the tangent to the circular path and move getting away from the earth .

Finding the orbital velocity of the satellite :

Assuming that there is a satellite of mass (m), moving at a constant velocity (v) in a circular path of radius (r), around the earth whose mass (M) as shown in the figure:



$$F_C = F_G$$

$$F = \frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$\therefore \frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$\therefore V^2 = \frac{GM}{r}$$

$$v = \sqrt{\frac{GM}{r}}$$

$$r = R + h$$
(r: radius of orbit, R: radius of earth)

- We notice that the gravitational force between the earth and moon is normal to the motion of the moon and it keeps the moon in a circular orbit .
- i.e.: the force of gravitation between the moon and the earth acts as a centripetal force

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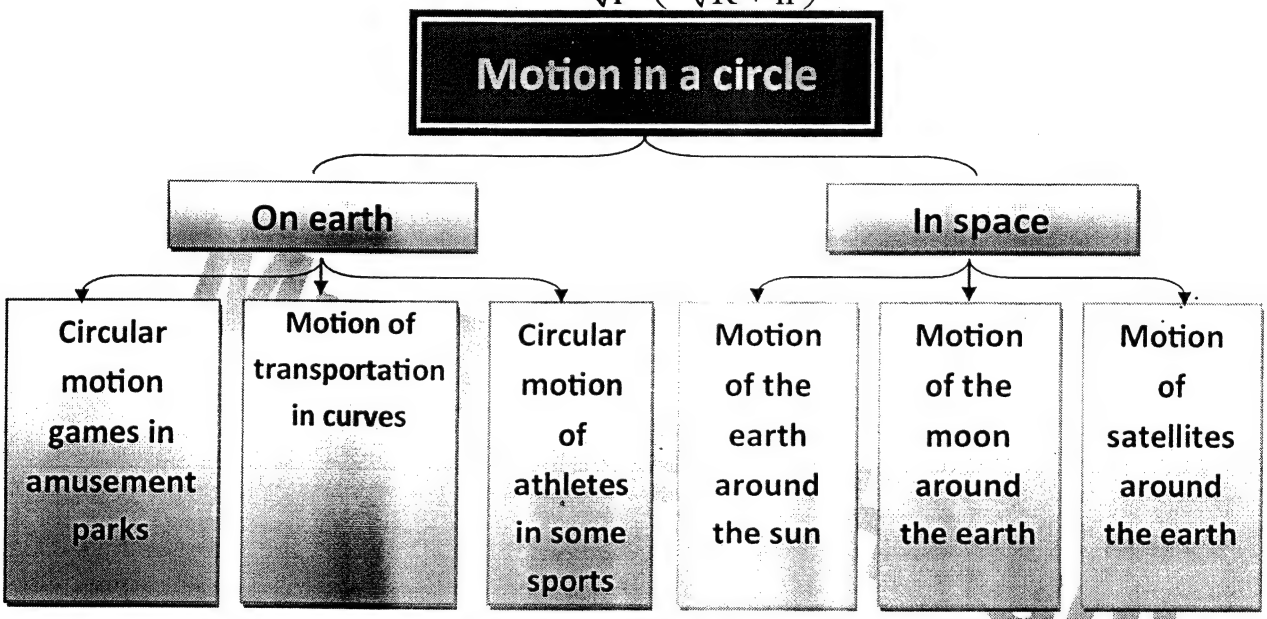
Factors affecting orbital velocity :

1- The mass of the planet around which the satellite rotates .

$$v \alpha \sqrt{M}$$

2- The height of the satellite away from the center of the planet around which it rotates .

$$v \alpha \frac{1}{\sqrt{r}} \left(\frac{1}{\sqrt{R+h}} \right)$$



Solved Examples

1. The moon rotates around the earth in a circular orbit whose radius is (3.85×10^5 km). It makes a complete revolution through (27.3 days). Calculate the mass of the earth (Universal gravitation constant ($6.67 \times 10^{-11} m^3 kg^{-1} s^{-2}$)

Solution :

Periodic time: $T = 27.3 \times 24 \times 60 \times 60 = 2.36 \times 10^6$ s

velocity of the moon: $v = \frac{2\pi r}{T} = \frac{2 \times 3.14 \times 3.85 \times 10^5 \times 10^3}{2.36 \times 10^6} = 1025 m/s$

Mass of the earth: $\because v^2 = G \times \frac{M}{r}$

Therefore : $M = \frac{V^2 \times r}{G} = \frac{(1025)^2 \times 3.85 \times 10^2 \times 10^3}{6.67 \times 10^{-11}} = 6 \times 10^{24} kg$

2. A satellite rotates around the earth in almost circular path at a height of (940km) away from the earth's surface . Calculate the orbital velocity , the time required by the satellite to make a complete revolution around the earth , knowing that :
(R_e = 6360 Km , M = 6 X 10^{24} Kg , G = 6.67 X 10^{-11} Nm^2/kg^{2+})

Solution :

Calculating the radius of rotation of the moon around the earth :

$r = R_e + h = 6360 + 940 = 7300\ km = 7.3 \times 10^6$

Calculating the orbital velocity :

$$v = \sqrt{G\frac{M}{r}}$$

$$v = \sqrt{6.67 \times 10^{-11}\frac{6\times10^{24}}{7.3\times10^{6}}}$$

$$v = 7.4 \times 10^{3}\ m/s$$

Calculating the periodic time :

$$v = \frac{2\pi r}{T} \qquad \therefore T = \frac{2\pi r}{v} \qquad T = \frac{2\times3.14\times7.3\times10^{6}}{7.4\times10^{3}} = 6195\ S$$

3. A satellite completes its revolution around the earth in (100min) and the length of its path = 60000 km . Calculate its orbital velocity , and its height above the surface of the earth , knowing that (R_e = 6360 Km) .

Solution :

Calculating velocity :

$$v = \frac{2\pi r}{T} = \frac{60000\times10^{3}}{100\times60} = 10000 m/s$$

Calculating height of the moon away from the earth :

$$2\pi r = 60000\times10^{3}$$

$$r = \frac{60000\times10^{3}}{2\times\pi} = 9.55\times10^{6} m = 9550 km$$

$$r = R_e + h$$

h = r − R_e = 9.55 X 10^{6} - 6360 X 10^{3} = 3190000 m

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Importance of satellites:

Usage of satellites has made a real revolution in many fields.

The satellite is considered as a very high tower used in sending and receiving the wireless waves.

There are many kinds of satellites .

1- Communication satellites:

They transmit phone calls , radio and TV signals to and everywhere on the earth's surface.

2- Astronomical satellites:

They are huge telescopes roaming in the space and they can image the orbs accurately .

3- Remote sensing satellites:

They are used in studying and monitoring the emigrant birds , determining mineral resources and their ratios underground, look out the agricultural yields to protect them from hazards of weather and studying the formation of hurricanes .

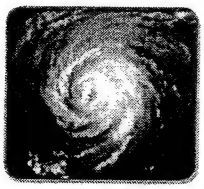
4- Explanatory and spying satellites:

They are satellites which abound the information needed by military and political leaders to make decisions and monitor combats.

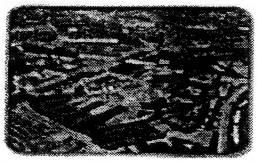
Technology and society

Satellites have contributed in changing life earth . for examples those satellites that orbit hundreds of kilometers away from you and affect on all aspects of your daily life . They enable you to watch satellite channels , follow the world news , know the weather forecasting and may help you in using the internet and your mobile phone . Also you can use them precise your location via the GPS , or to see your home from space view by using (google earth program) ... etc.

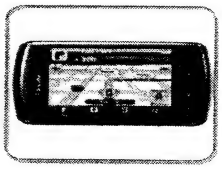
Satellite are used in communication



Satellite are used in studying hurricanes



Google maps imaged by satellites



GPS to determine locations

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Questions Chapter 2

Write down the scientific term for each statement of the following:

1. Each body in the universe attracts any other body by a force, this force is directly proportional to the product of their masses and inversely proportional to square of the distance between them.
2. Force of attraction between two bodies each of mass 1 kg and the distance between their centers 1 m.
3. Space in which the gravitational force appears.
4. The attraction force of Earth to a mass of 1 kg.
5. A body is launched in space with certain velocity to rotate in a curved path so that it has a constant distance from the Earth's surface.
6. The velocity required to keep the satellite rotate around the Earth in a roughly curved path so that it has a constant distance from the Earth's surface.
7. Huge telescopes roaming in the space and can image the orbs accurately.

Choose the correct answer of the given answers:

1.Force of attraction between two bodies in the universe is directly proportional to the.....
a. square of their velocities. b. product of their masses.
c. square of the distance between them. d. the distance between their centers.

2. The acceleration due to Earth's gravity is.....
a. a general universal constant.
b. changeable according to the height from the Earth's surface.
c. different through the seasons of the year.
d. changeable depending on the distance between Earth and Sun.

3. The centripetal force acting on a satellite of mass (m) rotates around Earth with velocity (v) in constant orbit of a distance (r) from Earth's center equals.....
a. $m\frac{v}{r^2}$ b. $m\frac{v^2}{r}$ c. $G\frac{m}{r}$ d. $G\frac{m}{r^2}$

4. The universal gravitational constant is determined using the relation G = ...
a. $\frac{Mm}{Fr^2}$ b. $F\frac{Mm}{r^2}$ c. $\frac{Mm}{r^2}$ d. $\frac{Fr^2}{Mm}$

5. The ratio between the universal gravitational constant on the Earth's surface to that on the Moon's surface is.....to unity.
a. less than b. more than c. equal d. three quarter

6. The unit for measuring the universal gravitational constant is.....
a. $N.m^2$. b. N/m^2 c. $N.m^2/kg^2$ d. $N.m^2.kg$.

7. The attraction force between Earth and Moon can be detected because of.....
a. their small masses. b. their large masses.
c. their small distances between them. d. their big radii.

8. If the distance between the centers of two masses decreased to its half, the force of attraction between them.....
   a. is doubled. b. increases 4 times.
   c. decreases to its half. d. does not change.
9. If the distance between the centers of two bodies is doubled, their masses are kept unchanged, the attractive force between them would be.....
   a. doubled. b. halved. c. quartered. d. increases 4 times.
10. Two bodies of mass (m_1) and (m_2) and the distance between them is (r). If the mass of the first body is doubled and the distance between them is also doubled, the force of attraction between them.....
    a. does not change. b. is doubled.
    c. decreases to its half. d. becomes 4 times its value.
11. Two balls of masses 8 kg and 20 kg , the distance between their centers is 0.2 m, if the universal gravitational constant is G, so the attraction force between them =.....N
    a. 8000 G b.4000G c.40G d. 8 G
12. If the distance between the centres of two identical balls is 1 m and the force of attraction between them is 1 N, the mass of each one of them equals.....
    ($G = 6.67 \times 10^{-11}\ N.m^2/kg^2$)
    a. 1kg. b. 1.22×10^5kg. c. 2×10^5kg. d.0.1 kg.
13. The intensity of Earth's gravitational field can be determined using the relation g=.....
    a. $\frac{Gm}{r^2}$ b. $\frac{F}{r}$ c. $\frac{\Delta v}{r}$ d. $\frac{FM}{r}$
14. A planet of mass 5.98×10^{24} kg and its radius R = 6378 km , if $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$, so the intensity of planet's gravitational field at a point lies at a distance 36000 km from its surface equals.....N/kg.
    a. 22.2×10^4 b. 22.2×10^2 c. 22.2×10^{-2} d. 22.2×10^{-4}
15. The orbital velocity that required to keep the satellite rotating around the Earth is given by.....
    a. $\frac{M}{r}$ b. gr c. $\sqrt{GM/r}$ d. $\sqrt{gr}$
16. The orbital velocity of a satellite is inversely proportional to.....
    a. the mass of satellite. b. square root of its mass.
    c. raduis of rotation of the orbit. d. square root of the orbital radius.
17. Two satellites A and B rotate around the Earth having the same periodic time. If the orbit radius of satellite A equals 4 times the orbit radius of satellite B. So, the ratio of velocity of satellite A to that of satellite B equals.....
    a.2: 1 b.4: 1 c. 1 : 2 d. 1 : 4
18. The time taken by a satellite to make full revolution around the Earth is given by
    a. $\frac{2\pi r}{v}$ b. $\frac{2\pi r^2}{v}$ c. $\frac{\pi r}{v}$ d. $\sqrt{\frac{2\pi r^2}{v}}$

19. The velocity required by a satellite to rotate around the Earth.....
    a. depends on its mass only.
    b. depends on mass of the Earth only.
    c. depends on both mass of the Earth and the distance between them.
    d. is constant.
20. The velocity of rotation required by the Earth to orbit the Sun depends on.....
    a. the mass of the Earth only.
    b. the mass of the Sun only.
    c. both the mass of the Earth and the Sun besides the distance between them.
    d. the mass of the Sun and the distance between them.
21. A satellite rotates at hight 12000 km from a planet of mass 9.96×10^{22} kg. If the radius of the planet is 1063 km and $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$. So, the orbital velocity of the satellite = ...m/s.
    a. 744 b. 713.13 c. 311 d. 249.9

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General exercise on the third unit

1) Put (√) tick to the right answer for each of the following:

1. The centripetal force of earth.
   a. The gravitational force of Earth.
   b. The friction force between the car tires and the road.
   c. The inertia affecting the car driver.
   d. The force of brakes.
2. If the radius of a circular orbit is increased to four times its original value, the centripetal force required to make the speed of the body constant would be:
   a. Decreased to haft
   b. Unchanged.
   c. increased to double.
   d. Decreased to quarter its value.
3. Two satellites (A) and (B) rotate around the Earth, having the same periodic time. If the orbit radius of satellite (A) equals four times the orbit radius of satellite (B), the ratio between the velocity of satellite (A) to that of satellite (B) equals :
   a. (2:1) b. (4:1)
   c. (1:2) d. (1:4)
4. If the distance between the centers of two identical bills is 1 m and the force of attraction between them is 1N, the mass of each one of them equals;
   a. 1 kg b. 122×10^5 kg
   c. 2×10^5g d. 0.1 g
5. If the distance between tie outers of two doubled and their masses are kept unchanged, the attractive force between them would be:
   a. Doubled. b. Halved,
   c. Quartered d. Increased four times,

2) A helicopter toy of mass 100 g flies to a circular path of radius 1 m and rotates at a rat of 100 revolutions in 20 s.

Calculate

a. The linear (tangential) velocity of the toy.
b. The centripetal acceleration.
c. The centripetal force.

3) Give reasons for each far the following:

a. Although body moving it a uniform circular motion acquires an acceleration its linear speed is constant.
b. It is dangerous to move at high velocities in curves of roads.

4) Write down the scientific terra few each of the following :

a. The motion of an object along the circumference of a circle at a linear velocity of constant magnitude and changeable direction. ( )
b. The time taken by a body to mike a completer revolution. ( )

c. A force always acts towards the center normally to the direction of the linear velocity during the motion of a body in a circular motion. ( )

5) Choose the proper unit from column (B) that fits each quantity in column, (A):

No	(a)	(b)
1	Periodic time	$N.m^2kg^2$
2	Centripetal force	m/s
3	Universal gravitational constant	m/s^2
4	Linear velocity	s
5	Centripetal acceleration	$Kg.m/s^2$

6) How high above the earth's surface should a satellite rotate so that its periodic time around the Earth equals the periodic time of Earth's spinning? Knowing that the Earth's day a 24 hours, the universal gravitational constant ($G = 6.67 \times 10^{-11}$ $N.m^2$ kg^4), the mass of the Earth ($M_E = 3.98 \times 10^{24}$ Kg), and the radius of the Earth (R = 6371 km).

Unit Four
Chapter one : Work and energy

Doing work requires:

1) A certain force acts on the object .
2) A certain displacement in the direction of the force .

$$W = F . d$$

F → Force (N) , d displacement (m)

Units : Joule = N.m = $Kg\ ms^{-2}.m$
$Kg\ m^2\ s^{-2}$

D.F. : $M\ L^2\ T^{-2}$

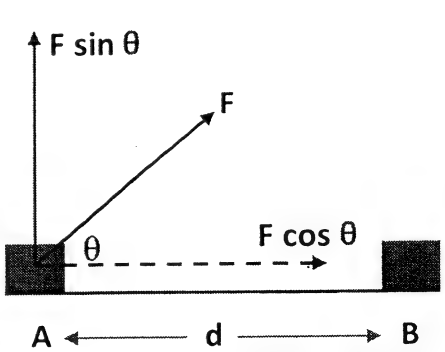
G.R. : Work is a scalar quantity

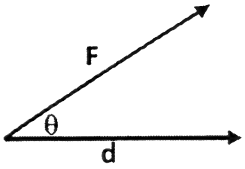
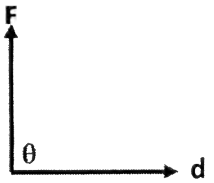
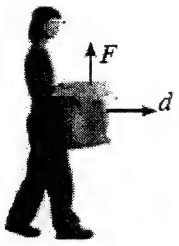
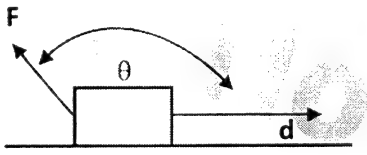
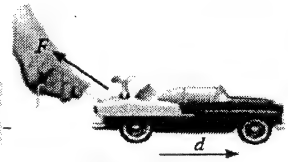
Because it is the dot product of two vectors (force and displacement)

- **Joule :** (1 J = 1 N . 1 m)
  It is the work done by force [1 N] to move an object (1 m) in its direction

- **Work :** It is the dot product of the force and displacement of an object in the direction of the force .

- If the direction of (F) is inclined at an angle (θ) to the direction of displacement .
  W = (F cos θ) (d)
  W = Fd cos θ



Angle (θ)	Work	Examples
$0 \le \theta < 90°$	<u>Positive</u> The person who does work	Pulling an object  
$\theta = 90°$	<u>Zero</u>	Moving while carrying an object  
$180° \ge \theta > 90°$	<u>Negative</u> The object does work on the person	A person tries to pull an object while moving opposite to the direction of the force  

Examples :

1. A cart of mass (20 kg) is pulled by a force of (50 N). The line of action of the force makes an angle (60°) to the direction of displacement Find the work done by the force to displace the car through 4 m (neglecting friction).

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Mr. Tarek Hosny
Mob. 01112577290

2. Calculate the work done by this girl who is carrying a bucket of mass (300g) to move it through a displacemet of (10m) in the horizontal direction . Then , calculate the work done by the boy to lift a bucket of the same mass (10cm) in the vertical direction (g = 10 m/s^2).

Solution :

- **Work done by the girl :**
  - Since the force exerted by the girl is perpendicular to displacement ,
  ∴ work done equals zero .
- **Work done by the boy :**

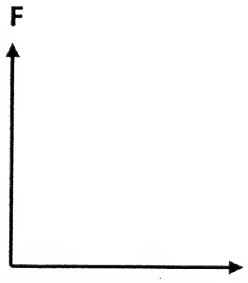
Finding the force :

$$F = mg = \frac{300}{1000} \times 10 = 3N$$

- **Work done :** $W = F.d\cos\theta$

Since force displacement are in the same direction , (θ) = 0

$$W = 3 \times \frac{10}{100} \cos 0 = 0.3\ J$$



No work is done when force is normal to displacement

Graphically:

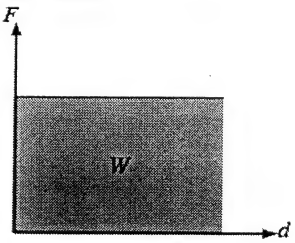
- Referring to the definition of work :

When $\theta = 0$

work = force × displacement = length × width

= the area below the curve in (force – displacement) graph

Therefore , graphically , work done = the area below the curve in (force – displacement) graph



Work done equals the area below the line

3. Find work done by force 100N acts on a body at rest so that its velocity becomes 20 m/s after 5 seconds .

Solution :

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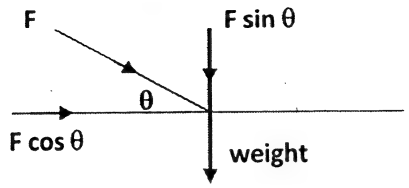
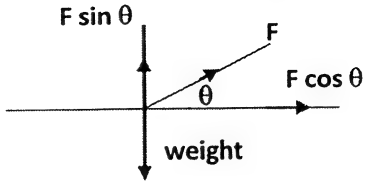
Pushing	Pulling
	
F sinθ acts in the same direction of weight so friction increases so work increases to move the body	F sinθ acts in the opposite direction to weight so friction decreases so work needed to move the body decreases

G.R. : Pulling is easier than pushing

Energy [K.E] , [P.E]

It is the ability [capacity] to do work .

Unit : Joule = N.m = kg m^2 s^{-2}

A) Kinetic energy [K.E]

It is the energy possessed by an object due to its motion .

What is meant by :

K.E. of body = 400 Joule

- The energy possessed by this body due to its motion = 400 Joule .

Gr. Work can be added to energy

Prove that K.E. = $^1/_2\ mv^2$

- **If a car moving from rest in straight line with uniform acceleration (a)**

$\because V_f^2 - V_i^2 = 2ad$

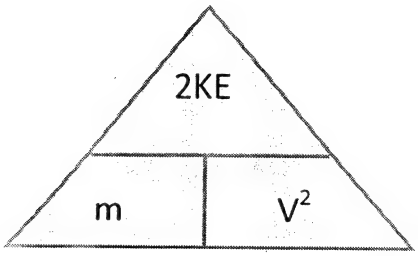
$\because V_i = 0 \qquad \therefore V_f^2 = 2ad \qquad \therefore d = \frac{V_f^2}{2a}$ **multiplying by (F)**

$\therefore Fd = \frac{FV_f^2}{2a}$

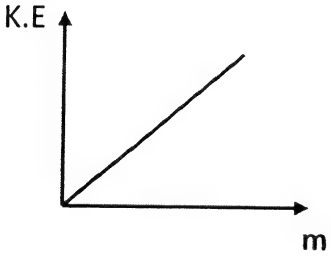
$\therefore Fd = \frac{1}{2}\left(\frac{F}{a}\right)V_F^2$

Fd: Work done; F: M

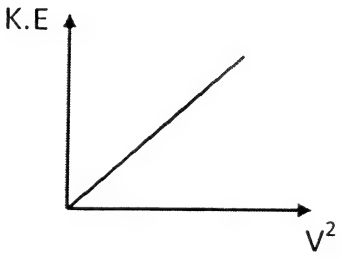
Or : energy needed to move a car so it is called KE



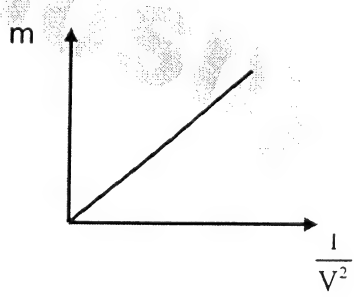
$K.E = \frac{1}{2}\ mV^2$



Slope = ...



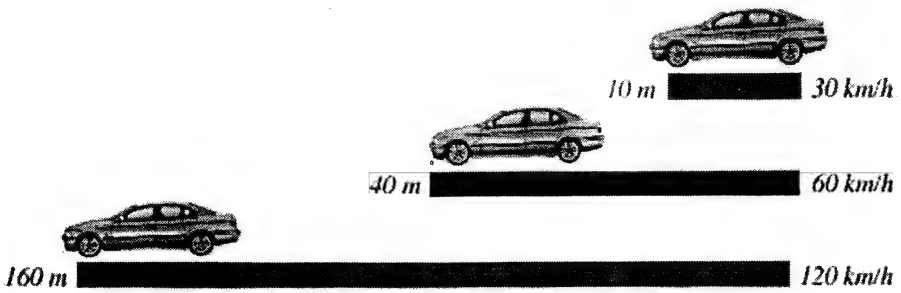
Slope = ...



Slope = ...

Through the relation :

- $K.E = \frac{1}{2} mV^2 = F.d$, **the work done is directly proportional to the square of the object speed .**
- **If we'd like to stop a car moving at velocity (60 km/h) by applying the brakes , the car would slid for a distance before stopping .**
- **This distance is four times longer than that needed if the car moves at velocity (30 km/h)**



Example:

- **Calculate the kinetic energy of a car [2000 kg] moving at speed [72 km / h]**

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Potential energy (PE)

- **It is the energy stored in an object due to its position**

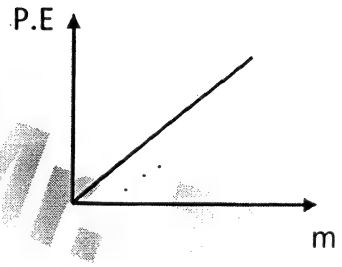
Prove that PE = m g h

If object of mass (m) is lifted to a height (h) work is done which equals

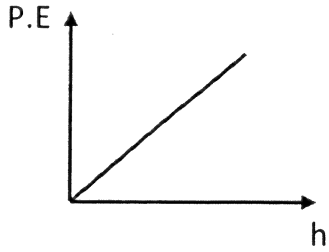
- **W = F h**
- **Force = weight = mg**
- **W = m g h**

- **W→This is the work done to put the body in a certain position so it is called (PE)**

PE = m g h



Slope = ...



Slope = ...

- **To lift a box into a truck , work must be done .**
- **In figure (12) we need a force of (450 N) to lift the box vertically to a height of (1 m) .**
- **On the other hand , we can raise the same box using less force (of 150 N) using a ramp (inclined plane) but with a greater displacement (3m) .**

Figure(12) : lifting the box vertically requires a force equal to weight , and the work done
W = 450 N X 1 m = 450 J

Figure (13) : When using a ramp , the box requires a force less than its weight but affects it for a longer displacement
W = 150 N X 3 m = 450 J

Example:

- Calculate the work done to lift an object of mass 50 kg to 2.2 m high above the ground (g = 10 m/s2)

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Point of comparison	Kinetic energy	Potential energy
Definition	The energy possessed by the object due to its motion	The energy possessed by the object due to its position or state
Mathematical expression	$K.E = \frac{1}{2} mV^2$	$P.E = m\,g\,h$
Affecting factors	Increases by increasing each of Object mass (m) Object velocity (v)	Increases by increasing each of Object mass (m) Hight above Earth's surfgace (h)
Unit of measurement	The joule	The joule
Dimensions	ML^2T^{-2}	ML^2T^{-2}

Questions Chapter (1)

Write down the scientific term for each statement of the following:

1. A scalar quantity equals the product of force x displacement.
2. Work done by a force of 1 Newton to move an object through a displacement of 1 meter in the direction of the force.
3. • Work done to move an object.
   • The energy possessed by the object due to its motion.
4. • The energy stored in objects because of their new positions or state.
   • Stored energy in a spring when compressed.

Choose the correct answer of the given answers:

1. Work is.....quantity and its unit of measurement.....
   a. scalar, N. b. vector, N. c. scalar, J. d. vector, J.
2. If the force acting on a body is doubled so that it covers the same displacement, then the work done.....
   a. increases 4 times. b. is doubled. c. decreases to its half. d. does not change.
3. Joule is equivalent to
   a. N.m. b. N/m. c. $N.m^2$ d. m/N.
4. Dimensions of work are .....
   a. MLT^{-1} b. MLT^{-2} c. ML^2T^{-2}. d. ML^2T^{-1}
5. If the direction of force is inclined by an angle 9 to the direction of displacement, the work done is determined by the relation W =.....
   a. F cos θ. b. Fd cos θ. c. Fd sin θ. d. Fd.
6. Work done is maximum when the direction of force makes an angle.....with the direction of displacement.
   a. zero b. 45° c. 60° d. 90°
7. An object moves a distance 10 m, while a normal force of 40 N acting on it. The work done in this case =.....
   a. 400 J. b. 40 J. C.4J. d. zero.
8. When the body moves in a direction makes with the force an angle 60°, then the work done will be.....
   a. zero. b. maximum. c. half maximum value. d. negative.
9. The work is negative if the direction of displacement.....the force.
   a. in the same direction of b. normal to that of
   c. opposes that of d. is inclined by an acute angle on
10. The work done by brakes is .....
    a. positive. b. negative.
    c. equals zero. d. there is no correct answer.

11. The kinetic energy of a body is determined using the relation.....

a. $\frac{1}{2}m^2v^2$ b. $\frac{1}{2}mv^2$ c. $\frac{1}{2}mv$ d. mv.

12. An object of mass 2 kg and has a kinetic energy of 25J , its velocity equals.....m/s.

a. 5 b. 12.5 c.80 d. 100

13. The kinetic energy of an object is 4 J. What is its kinetic energy if its speed is doubled?.....

a.0.8J. b.4J. C.16J. d.8J.

14. When the speed of a car is doubled, its kinetic energy.....

a. is halved. b. is doubled.

c. increases 4 times. d. remains constant.

15. If the velocity of an object is doubled and its mass becomes at fourth its value. So, its kinetic energy.....

a. decreases to its half. b. does not change.

c. decreases to its quarter. d. is doubled.

16. Two objects, the mass of the first is double that of the second and the first moves with velocity half that of the second. So, the kinetic energy of the first is.....that of the second.

a. half b. double c. quarter d. 4 times

17. The potential energy of an object at height (h) from Earth's surface equals.....

a. mgh. b. mgv. c. $\frac{1}{2}mh$. d. mh.

18. The stored energy in a compressed spring is.....

a. kinetic energy. b. potential energy.

c. attraction energy. d. repulsion energy.

19. An object of mass 2 kg is at 5 m high above the ground. Its potential energy equals.....

a. 98 J. b. 10 J. c.2.5J. d.9.8J.

20. If an object is projected upwards, which quantity becomes zero at its maximum height?.....

a. gravitational force. b. object acceleration.

c potential energy. d. object velocity.

21. A man went to his apartment twice; once using the stairs and another using the elevator. Which statement is correct?.....

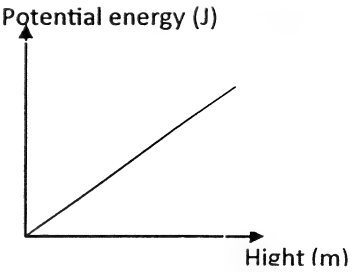
a. The man possesses more potential energy when using the stairs.

b. The man possesses more potential energy when using the elevator.

c. The man has no potential energy when using the elevator.

d. The man possesses the same potential energy in both cases.

22. The slope of the straight line in the opposite graph represents.....



a. object mass. b. object weight.
c. object displacement. d. object speed.

23. The potential energy of an object of mass 1 kg at the surface of the Earth equals.....
a. 98J. b.9.8J. c. 1 J. d.zero.

24. If g = 10 m/s^2, then the increase in potential energy of a student of mass 50 kg climbed a mountain to a height 5 m equals.....J.
a. 250 b.500 c.2500 d.25000

25. Mechanical energy of an object equals.....
a. the difference between its kinetic energy and potential energy.
b. the sum of its kinetic energy and potential energy.
c. the ratio between its kinetic energy and potential energy.
d. the product of its kinetic energy and potential energy.

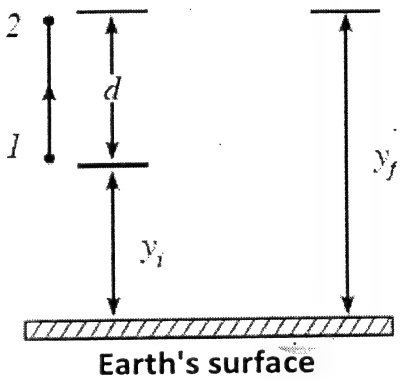
Unit four
Chapter two : Law of conservation of energy

- Energy is neither created nor destroyed but, it is converted from one form to another .

Law of conservation of mechanical energy :

- The sum of (PE) and (KE) of an object at any point on its path under the effect of gravity only is constant (ME) .
- When th body moves from point (1) to point (2) .
- PE increases why ?? due to increase in height .
  And KE decreases due to decrease in velocity

so $\boxed{a = -g}$



$$v_f^2 - v_i^2 = 2ad$$

$$v_f^2 - v_i^2 = 2(-g)d$$

$v_f^2 - v_i^2 = -2gd$ multiply by $(^1/_2\, m)$

$$\therefore \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(-2gd)$$

$$\frac{1}{2}m\,v_f^2 - \frac{1}{2}m\,v_i^2 = -mg\ \ \mathbf{d \rightarrow (y_f - y_i)}$$

$$\frac{1}{2}m\,v_f^2 - \frac{1}{2}m\,v_i^2 = -mg\,(y_f - y_i)$$

$$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = -mgy_f + mgy_i$$

$$\frac{1}{2}mv_f^2 + mgy_f = \frac{1}{2}mv_i^2 + mgy_i$$

$$(KE)_f + (PE)_f = (KE)_i + (PE)_i$$

$$\therefore (PE+KE)_1 = (PE+KE)_2 = \text{Constant} = ME$$

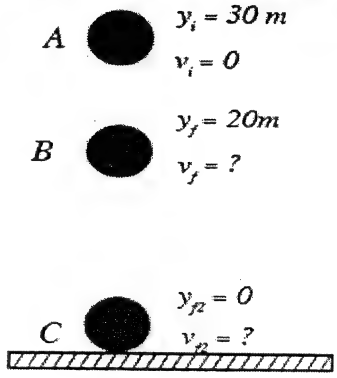
$$\therefore ME = PE + KE$$

Solved example :

A static object at (30 m) high above the ground has potential energy (1470 J). If this object falls neglecting the air resistance and consider g = 9.8 m/s², find:

1- The kinetic energy and potential energy of the object at (20 m) high.

2- The object velocity just before hitting the ground.



Solution :

At point A

P.E = mgh = 1470 J

m x 9.8 x 30 = 1470 J

m = 5kg

1- applying the law of conservation of mechanical energy at the points B and A:

$$\left[mgy_f + \frac{1}{2}mv_f^2\right]_A = \left[mgy_i + \frac{1}{2}mv_i^2\right]_B = ME$$

$$\left[5\times9.8\times20 + \frac{1}{2}mv_f^2\right]_A = \left[5\times9.8\times30+0\right]_B = 1470$$

$$\frac{1}{2}mv_f^2 = 490J = [KE]_B$$

- **kinetic energy of object at 20 m high is (490 J)**
- **Potential energy of object at (20 m) high:**
- **$[PE]_B$ = 1470 - 490 = 980J**

2- To find the object velocity just before hitting the ground:

applying the law of conservation of mechanical energy to the points

[C] and [A]

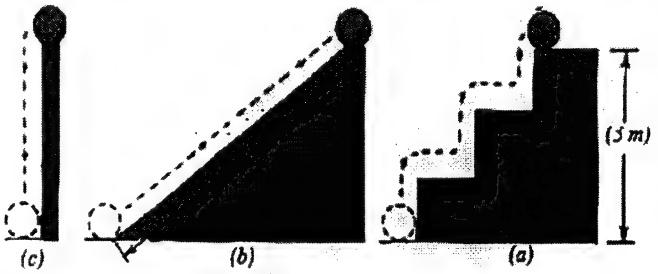
$$[5 \times 9.8 \times 30 + 0]_C = \left[0 + \frac{1}{2} \times 5 \times v_{f2}^2\right]_A$$

$$v_f^2 = 24.25 m/s$$

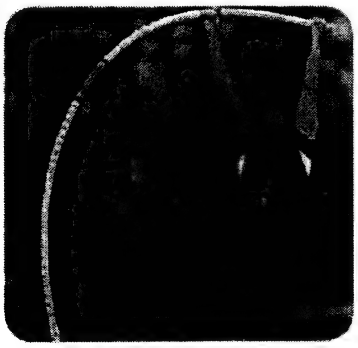
Thinking corner

Imagine three possible pathS for a ball lifted from the ground to reach the same hight each time . Which path makes the work done to move the ball the greatest ?

- Path a
- Path b
- Path c
- The same in all paths



There are examples of such transformation as indicated by the following figures :



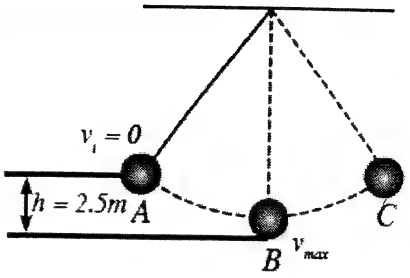
mutual transformation of kinetic energy and potential energy in vaulting

mutual transformation of kinetic energy and potential energy in flinging arrows

mutual transformation of kinetic energy and potential energy in roller coaster

Solved example :

The diagram illustrates a ball hung by a thread swinging in a certain vertical plane. If the ball mass is (4kg) and ($g = 9.8 m/s^2$), find the greatest velocity of the ball during oscillation, neglecting the air resistance.



Solution :

- oscillation is reached at the point (B).

- applying the law of conservation of mechanical energy at the points B and A

$$[mgh + 0]_B = \left[\frac{1}{2} mv_f^2 + 0\right]_A$$

$$4 \times 9.8 \times 2.5 = \frac{1}{2} \times 4 \times v_f^2$$

$$v_f = 7 m/s$$

Example : Body Falls

ME	PE	KE	
100	100	0	↓ The increase in (KE) at the experse of (PE) and vice versa when the body ejected upwards
100	90	10	
100	70	30	
100	50	50	
100	10	90	
100	0	100	

In a nutshell

- **Work :** the dot product of the force and displacement of an object in the direction of ' the force. It is a scalar quantity and measured in Joule.
- **The joule :** the work done by a force of one Newton to move an object through a displacement of one meter in the direction of the force.
- **Energy :** the capacity to do work.
- **Kinetic energy :** the energy possessed by an object due to its motion.
- **Potential energy:** the energy stored in an object due to its position.

Second main laws :

- **Law of conservation of energy:** Energy is neither created nor destroyed but it is converted from one form into another.
- **Law conservation of mechanical energy:** The sum of potential energy and kinetic I energy of an object at any point on its path under the effect of gravity only is constant.

Third : Main relation :

- $W = F.d \cos\theta = \Delta PE = \Delta KE$
- $K.E. = {}^{1}/_{2}\, mv^2$
- $P.E. = mgh$
- Mechanical energy =potential energy + kinetic energy
- $[PE]_{top} = [KE]_{bottom}$

Questions Chapter 2

Write down the scientific term for each statement of the following:

1. Energy is neither created nor destroyed, but it can be converted from one form into another.
2. The sum of potential and kinetic energies of a body.
3. The sum of potential energy and kinetic energy of an object at any point on its path under the effect of gravity is constant.

Choose the correct answer of the given answers:

1. Mechanical energy of an object equals.....
   a. the difference between its kinetic energy and potential energy.
   b. the sum of its kinetic and potential energies.
   c the ratio between its kinetic energy to potential energy.
   d. the product of its kinetic energy and potential energy.
2. When an object falls freely.....
   a. its potential energy decreases and its kinetic energy increases.
   b. both KE and PE increase.
   c. both KE and PE decrease.
   d. PE increases and KE decreases.
3. At half of maximum height for a projectile the ratio of KE to PE equals.....
   a. zero. b. $\frac{1}{4}$ c. $\frac{1}{2}$ d. 1
4. When an object is thrown upwards its.....increases.
   a. potential energy b. kinetic energy
   c. mechanical energy d. all of the previous
5. When an object is thrown vertically upwards, the sum of potential and kinetic energies.....
   a. increases. b. decreases.
   c. is constant at any point. d. equals zero.
6. The ratio between the mechanical energy of an object thrown upwards to its potential energy at maximum height equals.....
   a. $\frac{1}{2}$ b. $\frac{2}{1}$ c. $\frac{1}{1}$ d. $\frac{3}{1}$

General exercise on the fourth unit

1) Choose the correct answer for each phrase of the following;

a. The kinetic energy of an object is 4 J, what is its kinetic energy if its speed is doubted?

→ 8 J → 16J → 4J → 0.8J

b. An object of mass 2 kg is at 5 m high above the ground. Its potential energy equals:

→ 98J → 10J → 2.5 J → 9.8J

c. The stored energy in a compressed spring is;

→ kinetic energy. → potential energy,

→ nuclear energy, → repulsion energy.

d. If an object is projected upwards,, which quantity becomes zero at its maximum height?

→ Gravitational force. → object acceleration.

→ potential energy. → object velocity.

2) Give masons for:

a. Work is a scalar quantity.

b. Potential energy of water is greater at the top of a waterfall than that at the bottom.

c. A person carrying a suitcase does not do any work when moving horizontally.

3) A force of 100 N acts on an object to displace it through 2.5 m. find the work done by this face in the following cases:

a. If the force acts in the same direction of object motion.

b. If the force direction makes an angle 60^0 to the direction of object motion.

c. If the force acts perpendicular to the direction, of object motion,

4) Calculate the mass, of an object if its potential energy at a point 5 m high above the ground equals 980 J, and acceleration due to gravity = 9.8 m/s^2.

5) A ball of mass 0.5 kg is projected vertically upwards. If its velocity at 4 m high Is 3 m/s, find the work done to project the ball given that acceleration due to- gravity = 10 m/s^2.

6) An object of mass 4 kg falls freely from 20 m high above the ground. Fill in the blank cells in the following table, neglecting the air resistance and. given that (g = 10 m/s^2)

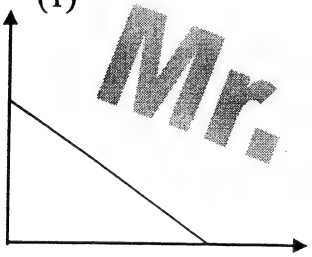
Point	Displacement (m) starting from point of falling	Potential energy (J)	Object velocity	Kinetic energy (J)	Mechanical energy (J)
A	0	.....	.....	.....	.....
B	.....	.....	5m/s	.....	.....
C	.....	400 J	.....	.....	.....
D	.....	.....	.....	800J	.....

Front the results you obtained, define the point, during, falling, at which:

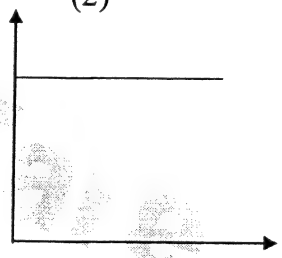
a. The mechanical energy of the object equals its kinetic energy
b. The mechanical energy of the object equals its potential energy
c. The kinetic energy of the object equals its potential energy

7) A body has been projected vertically upwards. You haw got three graphs(1,2 and 3); each of them expresses the relation between two physical quantities.

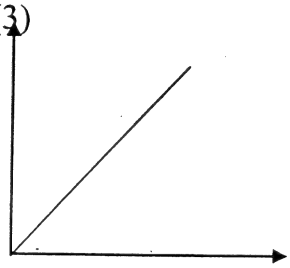
(1)



(2)



(3)



Decide on the graph represents that the relation between:

a. potential energy and object height above the ground.
b. kinetic energy and object height above the ground.
c. mechanical energy and object height above the ground.

Part (1)

Questions

1) Complete the following statements:

1- When a force acts on a moving body in the same direction, its speed ……. Without changing …….

2- When a force acts on a moving body in an opposite direction of its motion, its speed ……. without changing …….

3- If a body moves in a circular path, its velocity changes in …….

4- If the radius of curvature of the path of a body moving in a circular path increases four times , so the centripetal force required to make the speed of the body cost ant decreases to …….

5- From life applications of centripetal force are ……., ……. and …….

6- The centripetal force acting on a satellite of mass (m) rotates around Earth with velocity (v) in constant orbit of a distance (r) from Earth's center equals …….

7- The universal gravitational constant is determined using the relation G = …….

8- The ratio between the universal gravitational constant on Earth's surface to that on Moon's surface is …….. unity.

9- If the distance between the centers of two bodies is doubled the force of attraction between them becomes its ……value.

10- ……. is the unit for measurement the universal gravitational constant.

2) **Q2: What's meat by?**

1- Uniform circular motion
2- Centripetal force.
3- Tangential velocity
4- Reaction force
5- Centripetal acceleration
6- Periodic time
7- Universal gravitational law
8- Gravitational field
9- Gravitational field intensity
10- Satellite
11- Orbital velocity
12- Astronomical moon

3) **Q3: Give reason:**

1- Although the object moves in a uniform circular motion and is affected by an acceleration , it has a linear constant velocity.
2- When a car turns in a circular path , it conserves moving in the curved path.
3- Although the body moving in a circular path is affected by centripetal force, it doesn't go to center of the circle.
4- Racer leans his body with the motorbike towards the center of the circular path at the curved part of the path.
5- The driver must decrease his velocity in the curved path.
6- The attraction force between two masses increases as they move nearer to each other.
7- The orbital velocity keeps the satellite at the same height.
8- The importance of satellites.

4) **Q4: What do we mean when we say?**

1- The centripetal force acting on an object is 100N.

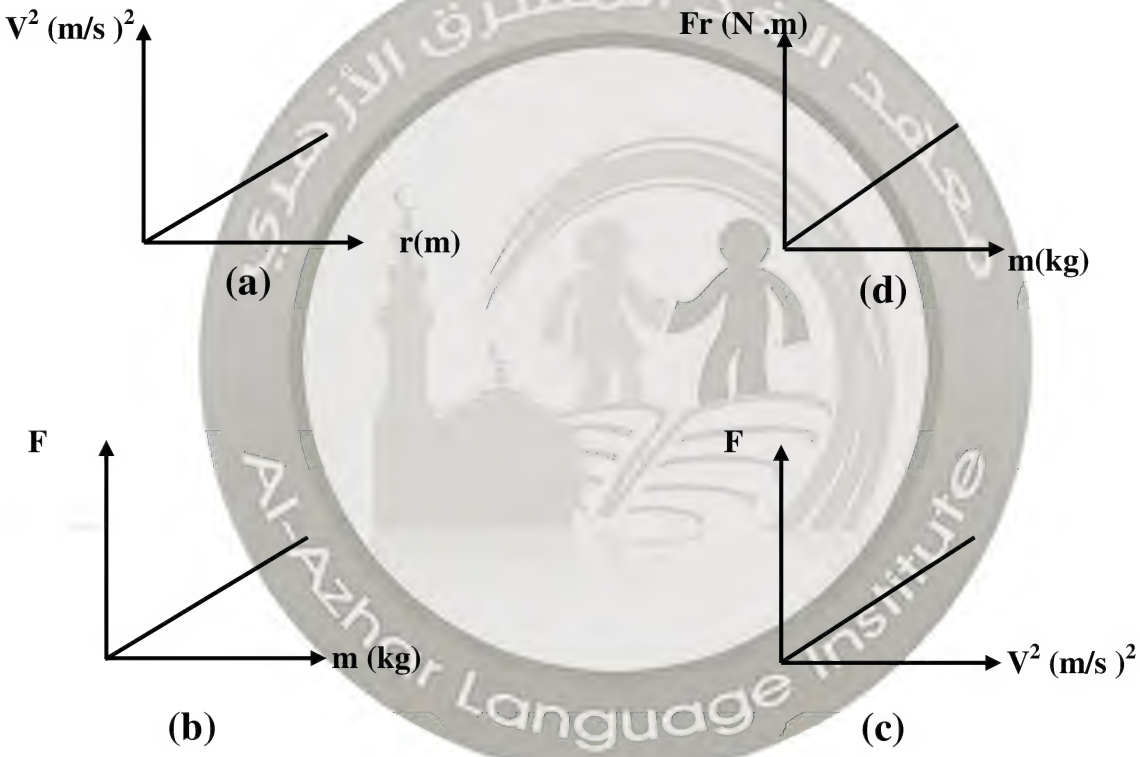
2- The centripetal acceleration of an object is 40 m/s^2.

3- The orbital velocity of a satellite = 9.7 X 10^4 m/s.

4- The gravitational filed intensity of the Earth = 10 N/Kg.

Q5: Write down the slope of the straight line and the mathematical relation for each of the following:

6)



Q6: Problems:

1- A bicycle rider move in a circular path of radius 40m.With tangential velocity 13.2 m/s. If the force that conserves the circular motion of the bicycle is 377 N. Calculate the mass of the bicycle and the rider.

2- A car of mass 905 kg. Moves on a circular path of radius 3.25m. , calculate the centripetal acceleration for the same object if its velocity is doubled and its radius of rotation decreases to its half value.

3- An object of mass 2kg is held at the end of a rope and rotate in a horizontal circular path of radius 1.5 m. so , it makes 3 revolutions in one second , calculate :

   a. The tangential velocity.
   b. The centripetal acceleration
   c. The tension in the rope

4- Find the mutual attraction between the sun and Jupiter giving that the mass of the sun 2×10^{30}kg , the mass of Jupiter 1.89×10^{27}kg and the distance between their centers is 7.73×10^{11}m ($G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$)

5- A mine is at 500m deep below the surface of Earth. Find the acceleration due gravity inside that mine giving that:
   (G) = 6.67×10^{-11} $N.m^2/kg^2$ (R) = 6360km (M) = 5.98×10^{24}kg

6- A planet has mass twice that of Earth and a diameter twice that of Earth. Find the ratio of the acceleration due gravity of the two planets.

Model Answer

Q1: Complete the following statements:

1) Increases – direction
2) Decreases – direction
3) Direction only
4) Its quarter
5) Candy floss – rotating barrels in amusement park – Drying cloths.
6) $m \frac{v^2}{r}$
7) $G = \frac{Fr^2}{mM}$
8) Equal
9) Quarter
10) $N.m^2/kg^2$

Q2: What's meant by?

1) The motion of a body in a circular path with constants speed and changeable direction.
2) The force acting continuously in a normal direction of the moving body changing its straight path into circular path.
3) The velocity of a body in the tangential direction of circular path at the release moment.

4) The force acting normally to the direction of a body moving in a circular path that is in clined to the horizontal towards the center of the curved path helping the body to move in a circular path.
5) The acceleration acquired by an object moving in a circular path due to a continuous change in the direction of its velocity.
6) The time taken by the body to make one complete revolution.
7) A body in the universe attracts another body by a force which is directly proportional to the product of their masses, and inversely proportional to square the distance between them.
8) The space in which the gravitational forces appear.
9) The gravitational force acting on a mass of 1 kg.
10) An object projected at a certain velocity to rotate in a roughly circular path at a constant distance from the Earth's surface.
11) The velocity that makes the satellite orbit Earth in a roughly circular path at a constant distance from the Earth's surface.
12) They are huge telescopes floating in space in which they can photograph space accurately.

Q3: Give Reason:

1) Because when the body moves in a circular path it will acquire a centripetal acceleration which changes the direction of the velocity without changing its magnitude.
2) Due to the friction force between the road and car tyers which is normal to the direction of motion of the car causing its motion in a curved path.

4) To create a force normal to the direction of motion so the direction of motion changes and the object moves in in a circular path.

5) Because according to the relation $F = \frac{mv^2}{r}$ when the car velocity decreases , F also decreases and the car doesn't skid out the road.

6) Because the gravitional force is inversely proportional to the square of the distance between the attracted masses.

7) Because the orbital velocity can be determined by the relation $V = \sqrt{\frac{GM}{r}}$ since M , G are constants then $V \propto \frac{1}{\sqrt{r}}$

8) Because it is used in different fields such as : Communication , photograph space accurately , determine the mineral resources and abound the information needed by military and political leaders.

Q4: What do we mean when we say……?

1) The force acting in a normal direction on the object's motion to turn it in a circular path is 100N.

2) The acceleration acquired by an object due to the change of its velocity direction during its motion in a circular path = $40 m/s^2$

3) The velocity which makes the satellite rotate in a curved path so that its distance from Earth's surface constant = $9.7 \times 10^4 m/s$

4) The attraction force of Earth to an object of mass 1kg = 10N.

Q5:

a- Slope = $\frac{v^2}{r}$ = a (centripetal acceleration)

$a = \frac{v^2}{r}$

b- Slope = a = $\frac{F}{m}$

F = ma

c- Slope = $\frac{F}{v^2} = \frac{m}{r}$

$F = \frac{mv^2}{r}$

d- Slope = $\frac{Fr}{m} = V^2$

$F = \frac{mv^2}{r}$

Q6: Problems:

1- $F = \frac{mv^2}{r}$

$m = \frac{Fr}{v^2} = \frac{377 \times 40}{(13.2)^2} = 86.5\text{kg}.$

2- $V = \sqrt{\frac{Fr}{m}}$

$= \sqrt{\frac{2140 \times 3.25 \times 10^3}{905 \times 2\pi}} = 34.97\ \text{m/s}$

3- a- $V = \sqrt{\frac{2\pi r}{T}} = \frac{2\pi \times 105}{\frac{1}{3}} = 28.26\ \text{m/s}$

b. $a = \frac{v^2}{r} = \frac{(28.26)^2}{1.5} = 532.4\ \text{m/s}^2$

c. $F = ma = 2 \times 532.4 = 10\ 64.8\ \text{N}$

4- $F = G\frac{Mm}{r^2}$

$= 6.67 \times 10^{-11} \times \frac{2 \times 10^{30} \times 1.89 \times 10^{27}}{(7.73 \times 10^{11})^2} = 4.22 \times 10^{23}\text{N}$

This force keeps Jupiter orbiting the sun.

5- $g = \frac{GM}{(R-h)^2} = \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(6360 \times 10^3 - 500)^2}$ 9.86 N/kg

6- $M_1 = 2\ Me$ $R_1 = 2R_e$

$\frac{g_1}{g_e} = \frac{M_1 Re^2}{M_e {R_1}^2} = \frac{2M_e Re^2}{M_e \times 4Re^2} = \frac{1}{2}$

Part (2)

Unit (4) Chapter (4) Work and energy

Define:

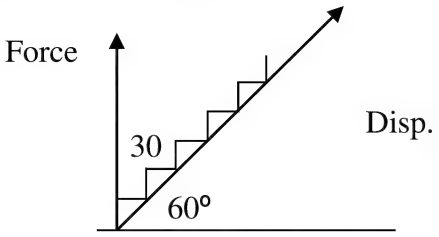
1. Work
   - The dot product of the acting force and the displacement in the direction of the force.
2. Joule
   - The work done by a force of one Newton to move an object through a displacement of one meter in the direction of the force.
3. Energy
   - The ability to do work.
4. Kinetic energy
   - The energy possessed by the object due to its motion.
5. Potential energy
   - The energy stored in the object due to its position or state.

Give reasons for:

1. The work done is a scalar quantity although both of force and displacement are vector quantities.
   - Because work is the dot product of force and displacement, which results in scalar.
2. The unit of energy is the same as the unit of work which is joule.
   - Because energy is defined as the ability to do work.
3. Work done can be negative.
   - When the angle θ between force direction and the direction of the displacement Is $> 90^\circ$ or the direction of force is opposite to the direction of the displacement.

Problems:

1. A man of a mass 70 kg ascends the stairs with angle 60° of length 50 m, calculate the work done ($g=10\ m/s^2$).



$F = m\ g = 70 \times 10 = 700\ N$

$W = Fd \cos\theta = 700 \times 50 \times \cos 30° = 30311\ J.$

2. A force affects on a body causing it to displace by 50 m in a direction makes angle 60° with the displacement, if the work done is 2500 j. calculate the force.

$W = F\ d \cos\theta$

$2500 = F \times 50 \times \cos 60°$

$F = 100\ N$

3. A force of 5 N acts on a body causing it to displace by 2m, calculate the work done in the following cases:
   a. If the acting force is normal to displacement direction.
   b. If the acting force makes angle 30° with the direction of displacement.
   c. If the acting force is in the same direction of displacement.

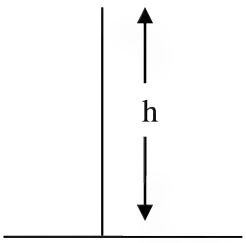
$W = F\ d\ Cos\ \theta$

a. $W = 5 \times 2 \times Cos\ 90° = 0$

b. $W = 5 \times 2 \times Cos\ 30° = 8.66\ J$

c. $W = 5 \times 2 \times Cos\ 0° = 10\ J$

4. A body of mass 50 kg, calculate its height from the Earth's surface if its potential energy at that height equals 2500 j ($g=10\ m/s^2$).



$P.E. = m\ g\ h$

$h = P.E. / m\ g = 2500 / 50 \times 10 = 5\ m$

Chapter (6) Law of conservation of energy

What is meant by:

1. Law of conservation of energy.

   Energy is neither created nor destroyed, but it can be converted from one form to another.

2. Mechanical energy.

   The sum of potential energy and kinetic energy of an object.

3. Law of conservation of mechanical energy.

   The sum of potential energy and kinetic energy of an object at any point on its path under the effect of gravity only is constant.

Give reasons for:

1. When an object falls freely its kinetic energy increases.

   Because the object's velocity increases due to gravitational acceleration and so, K.E. $= \frac{1}{2}$ m V^2

2. The sum of potential energy and kinetic energy of an object falling freely is constant.

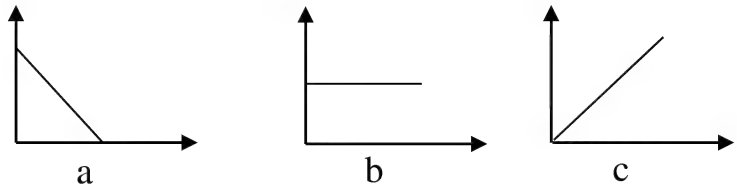
   Because according to the conservation law of energy as the kinetic energy increase P.E decrease and vice versa, so their sum stay constant.

An object is thrown vertically upwards, which of these graphs represents the relation between:

1- P.E. and h (c)

2- K.E. and h (a)

3- M.E. and h (b)

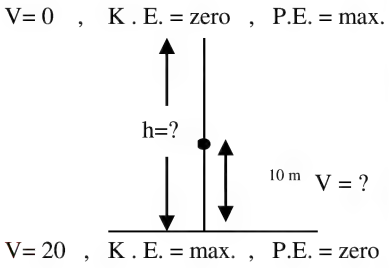


Problems :

1. An object of mass 0.2 kg is thrown upwards vertically with velocity 20 m/s, Neglecting the air resistance, calculate:

   – Maximum height the body reaches

   – The velocity at a height of 10 m



a. At the beginning of the movement (Earth's surface)

M.E. = K.E. + 0 = 1/2 m V^2 = 0.5 x 0.2 x 400 = 40 J

At max. height: M.E. = P.E. + 0 = m g h = 40 J

h = 40/ (0.2 x 10) = 20 m

b. at height 10 m

P.E. + K.E. = 40 J

0.2 x 10 x 10 + 0.5 x 0.2 x V^2 = 40 J ⟹ V = 14.14 m/s.

2. An object is thrown upwards vertically with initial velocity 10 m/s, if its potential energy at max. height is 1000 J, find its mass.

At max. height: M.E. = P.E. + 0 = 1000 J

At the Earth's surface: M.E. = K.E. + 0 ⟹ 1/2 m V^2 = 0.5 x m x100 = 1000 J

m = 20 kg.

3. A ball is thrown vertically upwards so that its velocity becomes 3 m/s at height 4 m, find the work done to throw the ball if its mass is 0.5 kg and g = 10 m/sec^2

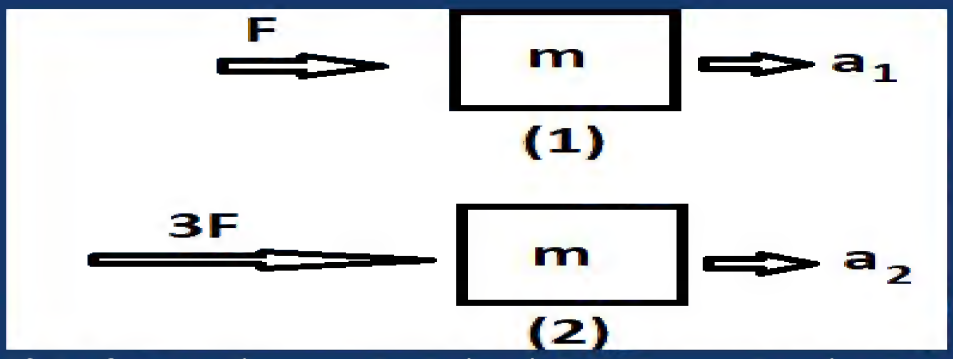
At height 4 m: M.E = P.E + K.E.

M.E. = m g h + 1/2 m V^2 = 0.5 x 10 x 4 + 0.5 x 0.5 x 9 = 22.25 J

Subject: Physics

Choose the correct Answer

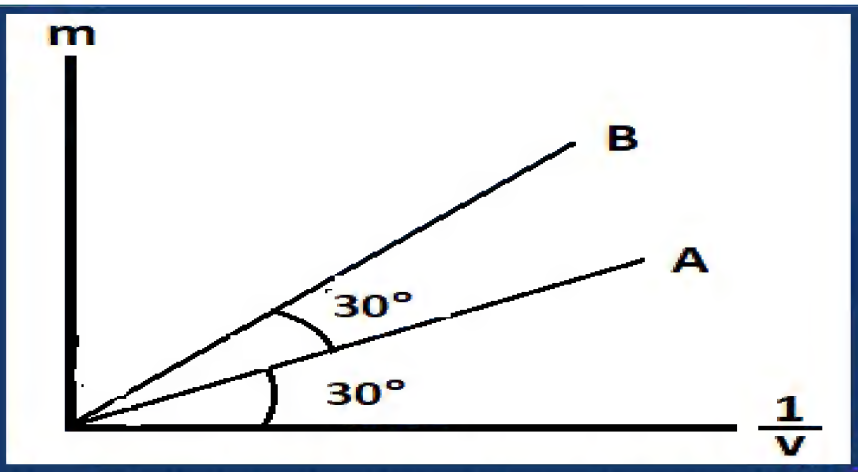
Q 11.



If the force acting on a body is tripled, the acceleration by which the body moves in the second case = …….

A)	$a_2 = 3\ a_1$
B)	$a_2 = 1/3\ a_1$
C)	$a_2 = 2\ a_1$
D)	$a_2 = 1/2\ a_1$

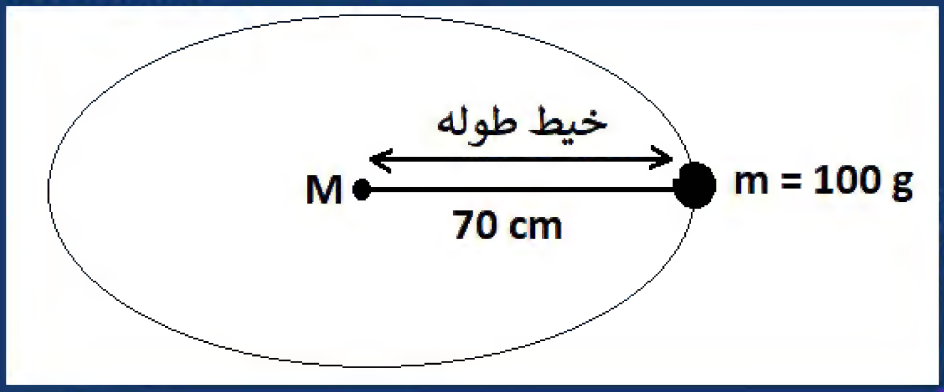
Q 12.



The graph illustrates the relation between the mass of the body and the reciprocal of its velocity ($\frac{1}{v}$). so, the ratio $\frac{\text{momentum of body (B)}}{\text{momentum of body (A)}}$ = ……

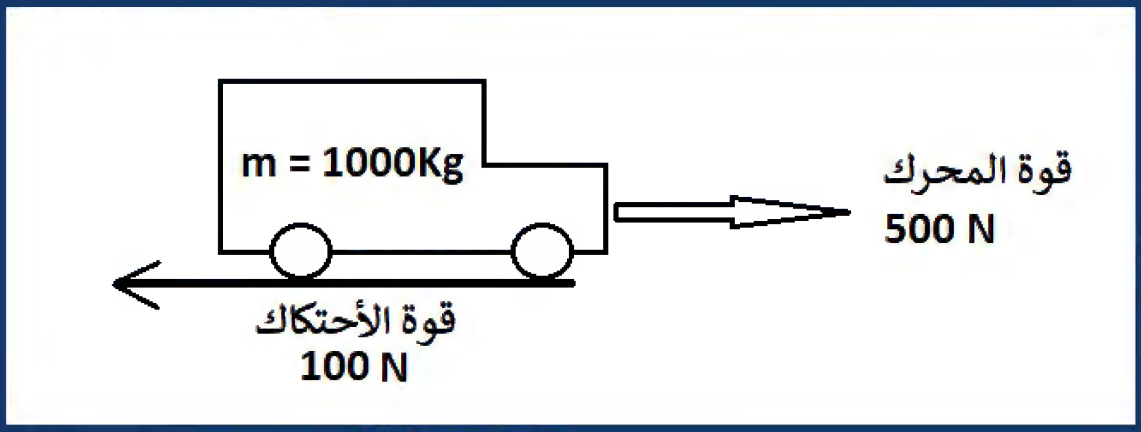
A)	2
B)	3
C)	$\sqrt{3}$
D)	1

Q 13. A body of mass 100g is tied to a thread of 70 cm long, makes 4 complete rotations around point (M) in 10 seconds. So, its centripetal acceleration = ...



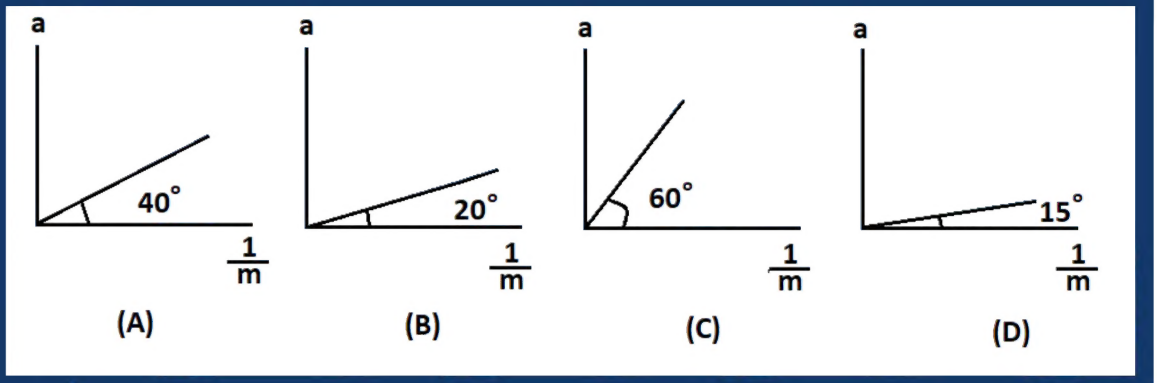
A)	$39.84\ m/s^2$
B)	$398.4\ m/s^2$
C)	$2.4\ m/s^2$
D)	$4.4\ m/s^2$

Q 14. Using the data on the figure , so, the acceleration at which the car moves .....



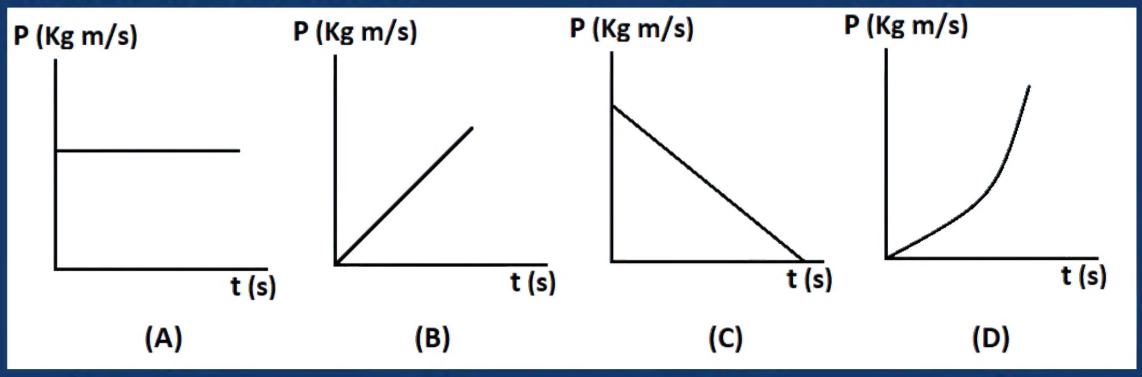
A)	$0.6\ m/s^2$ to the right
B)	$0.4\ m/s^2$ to the left
C)	$0.4\ m/s^2$ to the right
D)	$0.6\ m/s^2$ to the left

Q 15. The graphs illustrate how the acceleration changes as the reciprocal of the mass changes. Which one illustrates the greatest moving force .....



A)	**(B)**
B)	**(C)**
C)	**(A)**
D)	**(D)**

Q 16. The graphs illustrate the relation between the momentum of a body and time. Which graph illustrates a force which is opposite to the motion direction? .....

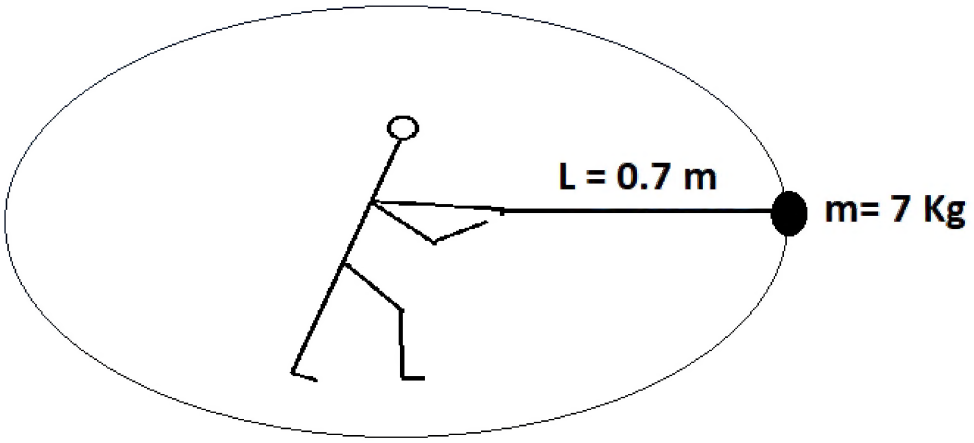


A)	**(C)**
B)	**(A)**
C)	**(D)**
D)	**(B)**

Q 17. A car of mass 1000 Kg moves in a curved road of diameter (50 m) at (10 m/s) speed. So, the friction force needed to keep the car from sliding out of the curve = ...

A)	**400 N**
B)	**2000 N**
C)	**4000 N**
D)	**200 N**

Q 18. In the hammer throw sport, knowing that the player makes (10) complete rotations in (8) seconds. Using the data on the figure. So, the tension affecting the player's arm = ...



A)	**302.5 N**
B)	**203.5 N**
C)	**305.2 N**
D)	**503.2 N**

Q 19. If the speed by which the body rotates in a circular path is doubled. So, the centripetal acceleration of the body .....

A)	**Remains constant**
B)	**Decreases to half**
C)	**Increases to double**
D)	**Increases four times**

Q 20. As a body rotates in a circular path, which of the choices is correct .....

	The linear acceleration	The centripetal acceleration
A)	Has a value	Has a value
B)	zero	zero
C)	Has a value	zero
D)	**zero**	Has a value

Subject: Physics

Answers

Question No	Symbol	Answer	
11.	A	$a_2 = 3\ a_1$	
12.	B	3	
13.	D	4.4 m/s^2	
14.	C	0.4 m/s^2 to the right	
15.	B	(C)	
16.	A	(C)	
17.	C	4000N	
18.	A	302.5 N	
19.	D	Increases four times	
20.	D	zero	Has a value

Laws and mathematical relations

1. Momentum of a body (P)

$P = m \cdot v$ **Kg.m/s**	Where (m) its mass and (v) its velocity

2. Force (F)

$F = \frac{\Delta P}{\Delta t}$ $F = m \cdot \frac{\Delta v}{\Delta t}$ $F = m \cdot a$ **N**	Where (m) is the mass of the body and (a) is the acceleration by which the body moves.

3. Weight of the body (F_g)

$F_g = m \cdot g$ **N**	Where (m) is the mass of the body and (g) is the acceleration due to gravity.

4. Centripetal acceleration (a_c)

$a_c = \frac{v^2}{r}$	Where (v) is the tangential velocity and (r) is the radius of the circular path.

5. The tangential velocity of a body moves in a circular path (v)

$v = \frac{2 \pi r}{T}$	Where (r) is the radius of the circular path and (T) is the periodic time.

6. The centripetal force acting on a body moves in a circular path (F_c)

$F_c = m \cdot a_c$ $F_c = m \cdot \frac{v^2}{r}$	Where (m) is the mass of the body, (v) is the tangential velocity and (r) is the radius of the circular path.